CERTIFICATE OF SERVICE

I certify that, pursuant to the Commission's Rules of Practice and Procedure, I have this day served a copy of the PROPOSAL TO PROVIDE A COMPREHENSIVE COMPRESSED AIR PROGRAM OF XENERGY, INCORPORATED FOR ADMINISTRATION OF 2002 ENERGY EFFICIENCY PROGRAMS on all parties identified on the attached service list. Service was effected by one or more means as indicated below:

- Placing the copies in properly addressed sealed envelopes and depositing such envelopes in the United States mail with first-class postage (via first class mail);
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- Transmitting the copies via facsimile, modem, or other electronic means (via electronic means).

Executed this 15 day of January, 2002, at Oakland, California.

Rich S. Barnes
Senior V.P. of Implementation
XENERGY, Inc.

492 Ninth Street, Suite 220
Oakland, California 94607
rbarnes@xenergy.com
510-891-0446

Service has been made to the following e-mail addresses:

sesco-lf@att.net, kmccrea@sablaw.com, darrell@iwfa.com, jimross@r-c-s-inc.com, rich.hogan@parago.com, wally.kolberg@swgas.com, ed.gieseking@swgas.com, andy.bettwy@swgas.com, ckmitchell@powernet.net, dnorris@sppc.com, jwhargrove@sppc.com, ceaston@sempra.com, pfeffer@scag.ca.gov, wallis@winegardenergy.com, arago@csi.com, laura.larks@sce.com, rsperberg@onsitenergy.com, kkam@sdenergy.org, vthompson@sempra.com, powerlogic@abac.com, Robsharp1@aol.com, cornstark1@aol.com, kmckenna@ambag.org, cal_broomhead@ci.sf.ca.us, marcel@turn.org, r0108028@cpuc.ca.gov, jes@cpuc.ca.gov, joe_como@ci.sf.ca.us, srovetti@puc.sf.ca.us, aselting@gralegal.com, ek@a-klaw.com, mmccormick@gralegal.com, pmiller@nrdc.org, rbm4@pge.com, jhamrin@resource-solutions.org, shallenbgr@aol.com, vfoster@cadvision.com, ted@energy-solution.com, donlink@jps.net, dacusjr@pacbell.net, mrufo@xenergy.com, twombly@kw-engineering.com, mrw@mrwassoc.com, pjpowerlaw@aol.com, swentworth@oaklandnet.com, bgwem@igc.org, carey.hamilton@ci.sj.ca.us, mike@comfortwise.com, gpeterson@mncee.org, rlw@rlw.com, jeff@jbsenergy.com, springer@davisenergy.com, bob.burt@macnexus.org, lmh@eslawfirm.com, jtachera@energy.state.ca.us, glynnisjones@earthlink.net, mpa@a-klaw.com, dan@meek.net, tom@ucons.com, dws@keywaycorp.com, reknuj@aol.com, tdavis5128@aol.com, jdrivera@drintl.com, martha.davis@appl.qe.com, staples@staples-ad.com, staples@staples-ad.com, sstrom@mncee.org, jcameron@arcainc.com, fspasaro@socalgas.com, susan-munves@santa-monica.org, dinalane@gte.net, danielf.duran@saic.com, thamilton@cheers.org, michaelgibbs@icfconsulting.com, dinalane@gte.net, don.arambula@sce.com, ipena@ecosconsulting.com, moore@ecosconsulting.com, kswitzer@scwater.com, rpustinger@rpmsolutions.org, dale.foster@ttemi.com, dale.foster@ttemi.com, jyamagata@sempra.com, mshames@ucan.org, gsanchez@rhainc.com, jon@vpideas.com, ywhiting@sdge.com, sthigpen@drintl.com, jlcraft@earthlink.net, bob.belhumeur@honeywell.com, toca@utility-savings.com, dwylie@aswengineering.com, ltgwiz@msn.com, lcasentini@drintl.com, ann_kelly@ci.sf.ca.us, jpeck@sempra.com, rcosta@turn.org, jcl@cpuc.ca.gov, mivp@chevron.com, akhan@imt.org, renee_fernandez@emcorgroup.com, vjensen@icfconsulting.com, jimflanagan@iname.com, rachel@ceert.org, slwb@pge.com, barbara@rhainc.com, tnicotre@slb.com, krfloyd1@hotmail.com, rknight@bki.com, bfoster@gepllc.com, gwikler@gepllc.com, jak@gepllc.com, rmowris@earthlink.net, etlowe@aol.com, misuriello@attbi.com, Jaybhalla@aol.com, msutter@home.com, bmast@frontierassoc.com, jerryl@abag.ca.gov, kcorfee@xenergy.com, rsflood@mindspring.com, jkelly@citizen.org, sschiller@nexant.com, rschmidt@bartlewells.com, drebello@qcworld.com, eparker@qcworld.com, ned2@ci.berkeley.ca.us, craigtyler@attbi.com, rdcaughron@earthlink.net, elvine@lbl.gov, rwwilson@lbl.gov, irina@ideasarecheap.com, john@proctoreng.com, john@proctoreng.com, dbleakly@peakstar.com., ina@speakeasy.org, timrosenfeld@earthlink.net, tconlon@geopraxis.com, rita@ritanortonconsulting.com, emahlon@ecoact.org, sam.driggers@ci.stockton.ca.us, terryhughes@afo.net, rmccann@cal.net, info@aeees.org, blaising@braunlegal.com, dmahone@h-m-g.com, dmahone@h-m-g.com, kcann@navigantconsulting.com, lindam@rcrcnet.org, westdakota@aol.com, dreynolds@aspensys.com, fdeleon@energy.state.ca.us, lynch@sl.net, pstoner@lgc.org, rnaylor@nmgovlaw.com, tracy.saville@dgs.ca.gov, TMichel@egia.com, dick@adm-energy.com, talereza@adm-energy.com, karen@klindh.com, jparks@smud.org, pfreedman@ecosconsulting.com, Ulrike_Mengelberg@pgn.com, john_mclain@pgn.com, carel.dewinkel@state.or.us, tom@ucons.com, bwildman@sbwconsulting.com, rbordner@emi1.com, MADUNHAM17@aol.com, rknecht@puc.state.nv.us, mer@cpuc.ca.gov, ru4@cpuc.ca.gov, dsh@cpuc.ca.gov, ewk@cpuc.ca.gov, jf2@cpuc.ca.gov, ska@cpuc.ca.gov, raw@cpuc.ca.gov, srt@cpuc.ca.gov, smo@cpuc.ca.gov, sfh@cpuc.ca.gov, zap@cpuc.ca.gov, tdh@cpuc.ca.gov, ztc@cpuc.ca.gov, asowell@scsa.ca.gov, dhungerf@energy.state.ca.us, dks@cpuc.ca.gov, gary_weitman@dca.ca.gov, mmesseng@energy.state.ca.us.

BEFORE THE PUBLIC
UTILITIES COMMISSION
OF THE STATE OF CALIFORNIA

2002 Energy Efficiency Program Selection R.01-08-028

Comprehensive Compressed Air Program

XENERGY

January 15, 2002

1 INTRODUCTION

1.1 OVERVIEW OF COMPREHENSIVE COMPRESSED AIR PROGRAM

XENERGY is pleased to present the California Public Utilities Commission (CPUC) with this proposal to conduct the ***Comprehensive Compressed Air (CCA)*** Program in the Southern California Edison and San Diego Gas and Electric service territories. CCA combines the information value of an audit program with the implementation focus of a Standard Performance Contract (SPC) effort, to form a single integrated program. This approach keeps the customer involved with CCA Program staff every step of the way, from identifying potential efficiency projects to installing and verifying savings levels. The CCA Program has a proven track record as an extremely successful approach to achieving significant compressed air savings that would otherwise remain untapped. Unique strengths of XENERGY's CCA program are summarized below:

Unmatched team of national experts. Team members have conducted hundreds of compressed air analyses, average over 20 years of industrial compressed air experience, and have published numerous guidebooks on capturing compressed air efficiency opportunities.

> Our success in previous CCA Programs with PG&E, NYSERDA, and Vermont was based principally on the technical expertise and customer relationship building skills of our lead auditors. It is vital that customers have absolute confidence in the competence of the auditors, and this is even more true for smaller customers. Our project team's senior compressed air professionals (Hank van Ormer, Bill Scales, and Henry Kemp) are recognized as national experts and major contributors to the Compressed Air Challenge Program led by the US DOE.

Industry-leading project close rate. CCA has achieved extremely high customer adoption rates in all of the service territories in which it has operated.

> Compressed air represents 15 to 30% of the total electric bill for many plants we have audited. Audit recommendations generally produce a savings level of 20 to 40% of the total electricity used to produce compressed air. Customer adoption rates through participation in CCA have averaged over 60 percent and reached almost 100 percent in the PG&E area for 2001.

Proven track record. XENERGY has successfully implemented CCA for Pacific Gas and Electric Company, the New York State Energy Research and Development Authority, and Central Vermont Public Service.

> In all programs to date, implementation rates have exceeded expectations. XENERGY met and then doubled its MW target while implementing CCA for PG&E as part of the Third-party initiative process.

The table below summarizes our goals and estimated cost-effectiveness for CCA:

CCA PROGRAM DESCRIPTION
Target Market Segment: Nonresidential Process Overhaul
Program Strategy: Energy Management Services and Incentives
Compressed Air Audits: 50 industrial sites in SCE and SDG&E service areas
Customer Incentives: $40 per MWh in lieu of SPC incentives (40 sites qualify)
Budget: $1600K ($800K for incentives and $800K for other costs)
Savings: 20,000 MWh (500 MWh X 40 sites) and 3.0 MW
KEY CCA PROGRAM METRICS
TRC Test Ratio: 3.16 ***Participant Test Ratio:*** 4.98
Program Efficiency: $80 in total program cost per MWh saved

Predicting success is always easier than achieving it. A key differentiator of our proposal is that we have we have more experience than any other firm in delivering savings from compressed air projects to meet a specified energy savings or demand reduction goal. Nearly 60% of payments in our 2001 CCA Program with PG&E were contingent on achieving verified savings levels, and those levels were achieved. We have proven our ability to meet or exceed firm savings goal, and at a very low cost.

PREVIOUS XENERGY CCA PROGRAMS

Central Vermont Public Service (1999-2000) - $158 per MWh (including engineering, customer incentive, and utility staff costs) on a total savings level of 6,200 MWh

NYSERDA (1999--current) – $80 per MWh based on 4,000 MWh in savings to date with more than 2,000 MWh in the pipeline

PG&E Cross-Cutting Demand Reduction (2000-01) - Original Goal 550 kW; Actual Savings 1000 kW by end 2001, with another 1000 kW by end 2002

2 TECHNICAL PROPOSAL

2.1 OVERVIEW OF KEY PROGRAM FEATURES

Key features of CCA are summarized below:

Target underserved customer segments. We are reserving 35 of the 50 CCA audits for "smaller" industrial customers, or those customers with less than a total electric demand of 800 kW. Historically, smaller industrial customers have not participated in utility programs at the same rate as larger industrial customers.

Target underserved geographical areas. Since PG&E has already proposed to the CPUC to continue their Compressed Air Management Program (CAMP) for PG&E customers, we have focused our CCA Program proposal on meeting the compressed air needs of customers in the SCE and SDG&E service areas. Industrial customers in these geographical areas are not likely to have participated in a program like CAMP, and naturally would not be served under the proposed PG&E program.

Minimize direct customer incentives. In the Vermont CCA Program (1999-2000), XENERGY pioneered the concept of using "coupon level incentives" of the order of $20 to $40 per MWh saved to spur customer implementation, rather than the $100+/MWh levels that had been used by the utility prior to 1999. Although the technical assistance cost component increased, the overall program cost ratio decreased from $287/MWh in 1998 (with the regular $100 per MWh customer incentive) to $158 per MWh (with the "coupon incentive" of $20 to $40 and XENERGY's involvement). A "coupon incentive" may not cost a great deal, but is highly effective. Projects in the PG&E CCA Program were completed with a maximum incentive of $125/kW, which translates to a range of $15-$30/MWh depending on the number of customer operating hours. The CPUC CCA Program is based on a "coupon incentive" of $40/MWh: the somewhat higher rate results from smaller customers potentially requiring a somewhat higher incentive rate to obtain the desired effect.

Make it easy for the customer to participate. Combining the audit function, implementation and customer incentive activities into a single program makes it easier for customers to participate, especially smaller customers. This integration also eliminates any potential double counting.

Leverage productivity benefits of air system improvements. We created significant productivity benefits from selected air system improvements for the customers of our PG&E, NYSERDA, and Vermont CCA Programs. These included improving the air quality of the air system by removing moisture and contaminates, increasing life expectancy of air system equipment, and reducing air system maintenance costs. Production rates increased at one site by nearly 50%; the rate of product rejects was reduced significantly at another site. Being able to identify and quantify such productivity improvements galvanizes customer support for recommended projects.

Leverage trade allies to help identify qualified customers. Trade allies such as compressed air service vendors helped to obtain good customer candidates for the PG&E CCA Program. We already have four vendors in the Southern California region ready to help with this CCA Program. We will also use industry trade groups and utility field staff to help with this process.

Develop an active tech transfer program to build a base of customer support. The CCA Program will include regular contact with trade groups and business media to chart progress of the CCA Program, develop case study write-ups of successful projects, and conduct two workshops during the program to build momentum and support for future CPUC efforts.

Provide CPUC with the option of increasing the size of the CCA Program. As proposed, the CCA Program will conduct 50 audits, spend $1.6 Million, generate 20,000 MWh in savings, and yield a TRC ratio of 3.16. XENERGY will give the CPUC the option of increasing the size of the CCA Program using the same overall metrics. For example, doubling the CCA Program would create a CCA Program with 100 audits, $3.2 Million in expenses, 40,000 MWh in savings, and a TRC Test Ratio of 3.16.

2.1.1 Market Barriers

Compressed air systems present significant opportunities for energy savings in the industrial sector. Based on the more than 200 compressed air audits we have conducted over the last five years, audit recommendations generally produce a savings level of 20 to 40% of the total electricity used to produce compressed air, more in isolated cases. Compressed air represents 15 to 30% of the total electric bill for many plants we have audited. These percentages are often higher for smaller industrial customers.

A few utility programs and groups such as the Compressed Air Challenge (CAC) led by US DOE have been very active and successful in generating awareness about compressed air opportunities and providing training and tools to help capture them. The difficulty that remains is getting customers to commit and install projects.

Discussed below are a number of market barriers that we have encountered in marketing compressed air projects, and some of the approaches we have used to overcome such barriers. Our project close rates (around 60% in Vermont and NYSERDA, and possibly 100% for PG&E) demonstrate that these barriers can be overcome.

- **"Make it easy."** The major market barrier is getting the customer to focus and act on any issue related to energy other than energy availability. Marketing strategies will likely fail if they require an upfront payment, signatures, or much effort from the customer before the audit. Production, not energy savings, is their chief concern. The CCA Program provides the compressed air audits at no cost to the customer and counts on a good customer screening process to prevent customers from wasting program resources. We "get in the door" of the right customer and count on the technical expertise and customer relationship management skills of our lead auditors to obtain buy-in quickly.

- **"Make it quick."** Even a week's delay after the initial customer contact can seriously erode the chances for closing a project. We produce an executive summary of what will be the final report before the auditor even leaves the customer's facility. This collaborative process produces both a clear understanding of customer needs and a commitment from the customer to move forward with the proposed projects. As part of the NYSERDA CCA Program, XENERGY developed an automated report template which greatly expedites preparation of audit reports, so that the auditor reaches this "commitment" stage by the last day of the site visit.

- **"Make it relevant."** Identifying and quantifying productivity benefits associated with air system improvements can galvanize the interest of the entire customer staff. Having compressed air systems directly impact production issues encourages customers to prioritize air system improvements.

- **"Make it right."** More than half of the typical customer contacts don't really understand their compressed air systems. If the lead auditor cannot establish technical credibility and a "partner" type relationship with the customer contact by the end of the first day, the project will most often fail to close. Key approaches for helping this happen include:

1. Recruit lead auditors knowledgeable about compressed air systems

2. Provide a clear snapshot of a customer's air system, its operating costs, and how the system will change with the recommended improvements

3. Incorporate the right level of measurement to fit the specific situation of the customer and characteristics of the air system and to provide tangible evidence to support the auditor's recommendations – our measurement activities range from a minimum of electric demand and pressure readings over short periods of time to trended measurements of electric demand and/or air flow over a 48-hour or 7-day period

4. Provide a comprehensive report of the audit findings that the customer contact can use to gain management approval and guide project design and installation.

2.1.2 Program Objectives

The primary objectives of the CCA Program are to:

1. Generate 20 million kWh in compressed air savings at a program cost of $1.6 million that will yield an overall program efficiency ratio of $80 in program costs per MWh saved

2. Improve the understanding and approaches of our industry to help capture an ever increasing share of potential compressed air savings at a lower program cost

3. Help establish a satisfied group of customers who will not only foster referrals for compressed air projects in the future, but also who can serve as advocates of the overall CPUC Program.

The CCA Program also achieves each of the policy objectives listed in the Energy Efficiency Policy Manual, as shown in Table 2-1.

Table 1-1. CPUC Energy Efficiency Program Policy Objectives and Achievement

Policy Objectives	CCA Program Feature
Long-Term Annual Energy Savings	• 20,000 MWh -- $1600K program costs and 50 audits • Many system improvements represent significant long-term changes – more efficient equipment, repiping, control systems, etc.
Addressing Market Failures or Barriers	• Project close rates averaging over 60% in three previous CCA Programs • Leverage of productivity impacts of air system improvements • Importance of technical credibility • Importance of relationship management skills
Equity Considerations	• Focus on smaller industrial customer firms (<800 kW) • Focus on underserved geographic regions (SCE and SDG&E service areas)
Cost Effectiveness	• TRC test ratio = 3.16 • Participation Test Ratio = 4.98 • Program Efficiency = $80 per MWh
Electric Peak Demand Savings	• 3.0 MW projected peak savings • Many system improvements represent significant long-term changes — more efficient equipment, repiping, control systems, etc.
Innovation	• Use of “coupon incentives” • Development of standardized report template to expedite analysis and report preparation

	• Use of trade allies for customer screening and cost information only, in order to avoid perceived conflict of interest in leading customer assessments • Concept of producing audit results and gaining the "emotional commitment of customer" during site visit
Synergies and Coordination	• Build on success of previous CCA programs • Audit team staff heavily involved with DOE CAC activities • Desired coordination with PG&E CAMP Program • Tech transfer activities to spur CPUC support

2.2 PROGRAM PROCESS

The CCA Program will conduct air system audits and provide customer incentives to reduce the level of electric use associated with producing compressed air. Several of the key attributes of the CCA Program concept are discussed below to highlight some of the program design issues that we have addressed. A copy of a reference book characterizing energy savings strategies in compressed air systems is included with this proposal. The reference book was developed by Hank van Ormer, one of the technical directors on this CCA Program.

Program Marketing and Outreach. The purpose of the Program Marketing and Outreach Activity is to attract customers who are likely to have good energy savings projects and inclined to fund such projects if they are identified. Customer leads will come from two sources: customer references from trade allies such as service vendors, utility reps, and trade organizations and customer inquiries from open solicitations through mailings and trade organization announcements. In the PG&E CCA Program, only 16 customers were contacted in order to get the 10 sites that were actually audited.

A copy of the CCA Program description used in the PG&E effort is included in the introduction to the forms in Appendix A. The purpose of the program description is to define the parameters and expectations of the program as customers move through the process. While we don't require a formal agreement from the customer at this stage, we communicate our expectation that a customer receiving a free audit should do so with the intent of moving forward with any reasonable projects that are identified.

An agreement is not asked for at this stage, because it would run counter to the concept of "making it easy" for a customer to participate. This works as long as we have reason to believe the customer has projects and can be expected to move forward based on knowledge provided by the trade allies. That this approach works is demonstrated by the fact that eight of the 10 PG&E audits have moved forward in implementing recommendations and the other two have signed intents to do so, once business conditions stabilize.

Customer Audits. The purpose of the customer audits is to identify cost-effective projects and motivate the customer to implement them. The range of potential projects used to improve the efficiency of compressed air is extensive. As part of the automated report template we developed for the NYSERDA CCA Program to help expedite the report preparation process, we created a list of 34 typical projects or measures that the auditor can draw on in assessing the customer's system. This list is provided in Table 2-2. Auditors are free to customize projects or measures that are not included in the pool.

Table 2-2. List of Potential Compressed Air Efficiency Projects

AIR COMPRESSOR SUPPLY
Replace current compressors or add new efficient units
Add trim or small compressor
Add or run small compressor during non-production times
Combine multiple systems into a single system
CAPACITY CONTROL
Correct capacity control operation or selection
Establish effective storage with more receiver capacity
Eliminate excessive pressure loss between compressor discharge and distribution system
Add central master control system
AIR TREATMENT
Add more effective or efficient compressed air dryer
Add dew point demand purge controller
Reconfigure or modify aftercooler to correct performance
Correct or replace pre- and after-filters with loose-packed deep-bed filters
Replace timer-activated drains with level-activated drains
Modify current process for handling condensate to be in compliance
Correct ventilation system
TRADITIONAL CONSERVATION MEASURES
Set up heat recovery system using heated cooling air or water
Replace existing motors with high-efficiency units
DISTRIBUTION SYSTEM
Correct main distribution header piping
Install demand-side control system with receiver or pressure/flow controller
Modify regulators and regulated flow at the point of use
Replace timer-activated condensate drains in distribution system with level-activated drains
Modify dust collectors
Implement an ongoing leak management program
Install automatic shut-offs on equipment
POTENTIALLY INAPPROPRIATE AIR USES
Reconfigure cabinet coolers
Replace open blows with Venturi amplifiers
Replace single-stage vacuum generator with multi-stage unit
Replace Venturi vacuum generator with a central system
Add automatic controls to Venturi vacuum generator
Replace air-operated diaphragm pump with electric units
Modify regulation of air-operated diaphragm pump to optimize performance vs. air use
Replace air motors or air hoists with electric units
Replace air vibrators with electric units
Install low-pressure air to replace or reduce high-pressure air

The audit includes seven basic steps.

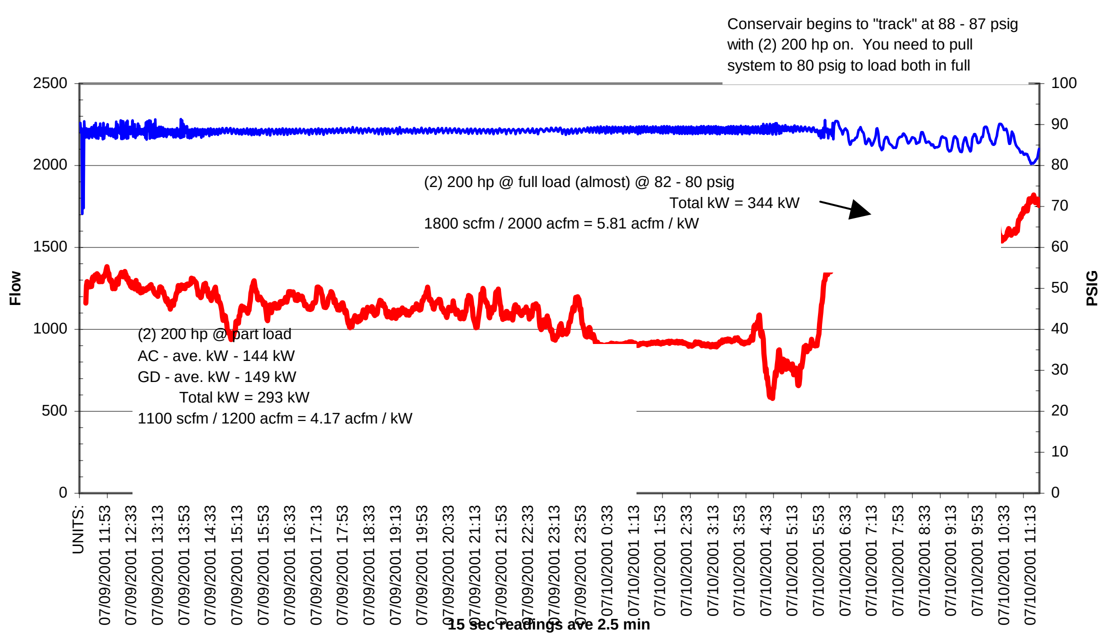
<u>Step 1 – Lead Qualification.</u> The first step when given a customer lead is to qualify it – i.e., determine whether it fits the parameters of the CCA Program. The lead is qualified via a phone contact from one of our Technical Directors (Hank van Ormer or Bill Scales) to describe the program and determine customer interest in moving forward and whether there are significant project opportunities base on an assessment of preliminary system information provided by the customer.

<u>Step 2 – Audit Scheduled.</u> If the customer lead is qualified, then the audit is scheduled. A preliminary measurement plan is developed based on our understanding of the customer's system characteristics and opportunities.

<u>Step 3 – Survey and Measurement.</u> The third step is the formal data collection activity associated with the audit itself. The audit starts with an informational meeting with the customer and continues with a tour of the facility. Measurement activities are initiated based on a preliminary measurement and modified based on what is actually occurring in the plant. Data characterizing both the major pieces of equipment in the air system and the data from the measurement activity is required for the plant assessment. Sample data collection forms used a typical audit are provided in Appendix A.

<u>Step 4 - Analysis.</u> Once the measurement data are collected, they are analyzed to identify potential project opportunities and to establish the operating baseline for the system. A sample measurement output from the PG&E CCA Program is provided in Figure 2-1.

Figure 2-1. Sample Site Measurement Results: Pressure/Flow Profile



Step 5 – Savings Projection. Once the identification of project opportunities is complete, the savings are aggregated to establish a projection of the operating baseline of the new system with the recommended projects in place.

Step 6 – Executive Summary. We then draft the Executive Summary so it can be presented to the customer on the last day of the site visit. A four-page excerpt from a sample Executive Summary is provided in Figure 2-2 at the end of this section and the full summary is included in Appendix B. The Executive Summary then serves as the center of discussion for the final audit meeting with the customer. Customers provide a sanity check on the improvement plan. The expectation is that the customer is emotionally committed to installing the recommended projects before the auditor leaves the site.

Step 7 – Final Report. The entire audit report is then finalized over the succeeding two weeks, approved by CPUC, if appropriate, and then forwarded to the customer for review. A sample of a Final Audit Report Notebook is provided with this proposal.

2.3 CUSTOMER ELIGIBILITY

All businesses with compressed air systems, which are located in the SCE or SDG&E service areas, are eligible to seek assistance through the CCA Program.

35 audits are reserved for customers with a total electric demand of less than 800 kW. This customer segment is difficult to make cost-effective audit investments in, and therefore has been underserved.

All air system sizes are possible, but systems with a connected load of less than 150 hp should have multiple units and a potential savings level of at least 50,000 kWh.

XENERGY reserves the right to pre-qualify customers before committing resources associated with performing an audit. XENERGY also reserves the right to limit the level of customer incentives to reflect an appropriate payback period for the customer.

Opportunities for reducing energy use in compressed air systems are found in every industry. The key is to get to the “right” customer, i.e., customers who:

- Have good potential savings projects
- Are willing to move forward and pay for projects once reasonable ones have been identified.

In the previous CCA Programs we have successfully used service vendors, utility reps, and trade organizations to identify and qualify these customers. These groups are the "trade allies" of the audit professional and are in the best position to know the status of individual customers.

2.4 PROGRAM PERFORMANCE GOALS

We agree to tie our 15 percent final performance payment to our gross energy savings goal of 20.0 million kWh and a demand reduction goal of 3.0 MW.

2.5 COST-EFFECTIVENESS CALCULATIONS

The cost-effectiveness calculations are based on results from the spreadsheet provided by the California Public Utilities Commission for use in proposing local programs for 2002 and 2003. The Total Resource Cost (TRC) and Participant Test ratios for the CCA Program are 3.16 (TRC) and 4.89 (Participant). The annual energy, demand and therm savings attributed to this program are 20,000 MWh, 3.0 MW and 0 therms, respectively.

An electronic spreadsheet file (XENERGY CCA.xls) is provided with this proposal package.

Included in Table 2-3 is a list of 34 typical projects we use in completing reviews of compressed air systems. Any single audit might include 5 to 10 such projects drawn from the list, plus a couple of custom measures not included in the list. The mix of projects and resulting savings levels will be unique to each customer.

The best way to complete the Cost-Effectiveness Calculations spreadsheet is to determine a typical savings level, and prepare the data entries on the spreadsheet based on that overall average, rather than spelling out individual measures.

Sample results from more than 23 customers participating in the other CCA Programs are reported in Table 2-2. Each customer is characterized by "size" and "business activity" or SIC code. The table lists the four recommended projects with the greatest savings level for each customer.

The sample includes 11 "Smaller" customers (< 800 kW in total electric use) and 12 "Larger" customers (> 800 kW in total electric use). The average savings estimate was 280 MWh for the "Smaller" customers and 1,050 MWh for the "Larger" customers. Average project payback period was less than one year for both groups. Significant savings levels were found in every industry group.

The assumptions and data sources for the spreadsheet entries are listed below.

Number of Units = 40. This number is the product of "Number of Customer Sites Audited" and the "Project Close Rate." The "Number of Customer Sites Audited is set at

50 audits based on the scope of the CPUC CCA Program. The "Project Close Rate" is the percentage of audited customers who implement a major portion of the recommended savings projects. Project Close Rates have averaged in excess of 60% over the three previous CCA Programs. The actual rate has increased in each successive CCA Program with Vermont averaging just above 50%: NYSERDA, about 60%, and PG&E 80%-100%.

Table 2-3. Previous CCA-Type Programs: Savings Summary

SIC Code/Company Business (Company Size)	Project Costs ($)	Project Savings ($)	Payback (Months)	Savings (kWh)	Project Opportunities (Listed in order of savings magnitude)
SIC 20 – Food Products (Large firm)	$35,060	$106,433	4 months	444,714 kWh	Convert unloading controls and correct header piping Install demand-side control system Implement repair leak program Establish heat recovery system
SIC 20 – Food Products (Small firm)	$20,446	$14,513	17 months	202,969 kWh	Replace existing dryers Replace timer drains Use unloading controls and repair leaks Replace filters
SIC 20 – Food Products (Large firm)	$148,600	$238,000	7 months	925,400 kWh	Correct capacity controls Add more efficient air dryer Correct or replace pre- and after-filters Correct main distribution header piping
SIC 20 – Food Products (Small firm)	$20,000-$40,000	$23,900	1-2 years	311,100 kWh	Combine three separate air systems into one Modify current process for handling condensate Implement continuing leak repair program Replace open blows with Venturi amplifiers
SIC 20 – Food Products (Small firm)	$28,000 to $48,000	$27,000	12 to 21 months	227,700 kWh	Convert from two systems to one and shut off a dryer Add central master control system Install demand-side control system with controller Repair remaining bag houses – install indicator lights
SIC 20 – Food Products (Large firm)	$167,900	$142,300	14 months	1,897,700 kWh	Install small compressor for non-production times Eliminate excessive pressure loss Reconfigure or modify aftercooler Replace manual drains w/ level-activated drains
SIC 20 – Food Products (Large firm)	TBD	$20,000	< 18 months	1,000,800 kWh	Re-pipe and combine high- and low-pressure systems Replace three timer-activated drains w/level-activated Implement an ongoing leak program Reconfigure cabinet coolers with temp entry on/off

SIC Code/Company Business (Company Size)	Project Costs ($)	Project Savings ($)	Payback (Months)	Savings (kWh)	Project Opportunities (Listed in order of savings magnitude)
SIC 25 – Furniture (Small firm)	$33,000	$20,599	18 months	186,152 kWh	Correct filters and repair leaks Install demand-side control system Replace open blow offs Install low-pressure air supply for finishing prod line
SIC 26 – Paper Products (Large firm)	$44,900	$47,800	11 months	597,700 kWh	Add back-up compressor in facial tissue plant Replace all timer drains with level-activated drains Replace air knife Venturi amplifiers
SIC 26 – Paper Products (Large firm)	$13,100	$43,000	4 months	573,200 kWh	Correct capacity control operation Eliminate excessive pressure loss in compressor area Shut off Premier dryer during production Remove GEMOC dryer from service
SIC 26 – Paper Products (Large firm)	$198,630	$139,856	15 months	2,061,398 kWh	Correct unloading controls and correct header piping Replace pre- and after-filters Install demand-side control system Add rotary screw compressor
SIC 26 – Paper Products (Small firm)	$28,400	$35,000	9 months	185,400 kWh	Reconfigure current compressors and add new units Add or run small compressor during non-production Install demand-side control system with controller Install low-pressure air to replace/reduce high-pressure
SIC 27 – Printing (Large firm)	$52,355	$88,265	6 months	1,091,548 kWh	Correct unloading controls Correct header and piping pressure losses Replace undersized dryer Install demand-side control system
SIC 28 – Chemicals (Large firm)	$80,600	$161,400	6 months	980,000 kWh	Run larger units at full load, not several at part load Establish effective storage piping modifications Eliminate excessive pressure loss in compressor area Replace timer-actuated drains with level-activated
SIC 30 – Plastics (Large firm)	$60,000 to $120,000	$121,000	1 year	1,213,000 kWh	Combine central power and rotary low pressure system Add central master control system to keep at full load Implement an ongoing leak program Replace open blows with Venturi amplifiers
SIC 32 – Glass Products (Large firm)	$69,200	$62,400	13 months	762,300 kWh	Reconfigure from three separate systems to one Correct or replace pre- and after-filters w/deep-bed Implement ongoing leak management program Add Vortex cooler to blow off to cool building

SIC Code/Company Business (Company Size)	Project Costs ($)	Project Savings ($)	Payback (Months)	Savings (kWh)	Project Opportunities (Listed in order of savings magnitude)
SIC 32 – Stone Products (Small firm)	$36,700	$38,720	11 months	465,524 kWh	Replace pneumatic diaphragm pump with electric Run small compressor off-peak Implement leak repair program Install demand-side control system
SIC 33 – Foundry (Small firm)	$34,500	$42,319	10 months	285,559 kWh	Correct system to shut off one compressor Run non-production hours with smaller compressor Correct header and piping connections Install demand-side control system and repair leaks
SIC 34 – Metals Fabrication (Small firm)	$58,300	$17,800	2 months	417,800 kWh	Replace compressor with more efficient SR drive Install 660-gallon receiver and repipe compressor area Add more effective air dryer Install mist eliminator and level-activated drains
SIC 35 – Mechanical Equipment (Small firm)	$6,500	$4,000	20 months	61,200 kWh	Replace timer-activated drains with level-activated Implement an ongoing leak identification/repair program Set up heat recovery system w/heated cooling water to offset natural gas use
SIC 37 – Electric Products (Large firm)	$27,050	$60,200	5 months	970,600 kWh	Replace current compressors or add efficient units Add dew point demand purge controller Implement leak repair program with ultrasonic locators Replace open blows with Venturi amplifiers
SIC 37 – Electronics (Small firm)	$21,300	$29,417	9 months	392,079 kWh	Replace open blow offs Install demand-side control receiver Replace timer drains
Sic 39 – Misc Manufacturing (Small firm)	$38,800 to $42,800	$40,600	11 months	452,100 kWh	Correct capacity control operation Eliminate excessive pressure loss Add more efficient air dryer Install demand-side control system

2.6 EVALUATION, MEASUREMENT AND VERIFICATION PLANS

Evaluation of programs is critical to ensuring accomplishments and improving programs over time. Members of the team, Quantum Consulting and XENERGY, have been leaders in energy program evaluation for over two decades. Evaluation must also be well tailored to the specific characteristics of the programs.

Our evaluation approach for this program will be focused on verifying installation of the measures, determining the actual level of energy savings, and measuring participant satisfaction with the CCA Program experience.

Verification of Installation. One of the advantages of a CCA Program having direct involvement with the local service and installation vendors is the ability to closely track project implementation progress. Accordingly, XENERGY will conduct a verification survey on a all system installations, while Quantum Consulting will follow-up with verification of a random sample of participants near the end of the program period.

Energy Savings. Estimation of actual energy savings is relatively straightforward. During the M&V process, after implementation, the customer site will be re-measured to determine the difference between the projected and the actual operating performance of the new system. Any significant differences then need to be accounted for and may be attributed to different production processes, production rates, or product mixes. XENERGY will establish the baseline for both the pre- and post-project measurements and perform the actual measurements for every site that implements the recommended projects. Quantum Consulting will then evaluate and interpret the collected data.

Process Evaluation/Customer Satisfaction. A survey will be developed that will be left with program participants. The survey will generally focus on their satisfaction with the program process and measures installed. Participants will be instructed to mail their surveys to Quantum Consulting. Depending on the rate of return, Quantum Consulting may conduct a telephone survey of an additional sample of non-respondents.

2.7 DESCRIPTION OF IMPLEMENTER'S QUALIFICATIONS

The three CCA Programs that XENERGY has previously developed for other clients are the most relevant qualifications for the proposed CCA Program. Each of these efforts exceeded program goals by a significant margin and contributed greatly to the development of approaches and individual staff included in this CCA Program proposal. Key characteristics of these three prior CCA Programs efforts include:

Central Vermont Public Service (1999-2000)

- 6200 MWh in savings or 100% more than goal
- $158 in program costs per MWh saved
- 54% close rate (where the "close rate" is the percentage of sites that implemented a major portion of the recommended package of improvements)

NYSERDA (1999-current)

- 4000 MWh in savings already implemented plus another probable 2000 MWh in the pipeline – 50% more than goal
- $80-110 per MWh
- 63% close rate

PG&E (2000-current)

- 1000 kW in demand reduction or 80% more than goal

- $480 per kW
- 80% close rate (100% if two sites who submitted letters of intent move forward)

In addition to these “audit programs”, the eight members of XENERGY’s audit team have collectively performed over 600 additional audits of compressed air systems. A list of clients for whom these audits have been conducted is included in Table 2-4.

Audit team members average more than 20 years of experience working with compressed air systems and are active with the US DOE Compressed Air Challenge (CAC) Program. Hank van Ormer, Bill Scales, and Henry Kemp are regarded as being industry leaders in terms of conducting plant assessments and making air systems work. All three are certified as CAC Level I/II instructors.

Table 2-4. List of Compressed Air Audit Clients

BUILDING PRODUCTS

Allied Mineral
Allied Signal
Conway Lumber
Kentile
Malta Windows
Norco Windows
*Owens Corning
*PPG Industries
Shamrock Conduit
*Sherwin Williams
*Superior Hardwood
Weathershield

CHEMICAL AND PHARMACEUTICAL

*Bayer
BP Amoco
Cerl
Crossfield Chemical
*Dupont
Georgia Pacific,
ISP Fine Chemicals
Jamalco, Jamaica
Johnson & Johnson
Kodak
Noramco
Pharmacia Upjohn
PPG
Roche Vitamin

COMMUNICATIONS/ ELECTRONICS

Applied Materials
CompuServe
Foxboro
LAM Research
*Lucent Technology

ELECTRIC POWER PLANTS

*American Electric Power
American Generating Company
British Virgin Islands Electric Corp.
Lansing Board of Water and Light, Lansing, Michigan
Southern Illinois Power
Virginia Power
*Wisconsin Power and Light

FOOD AND FOOD PROCESSING

*American Bottling
Associated Milk Producers
Berry Callebaut U.S.A., Inc.
Bloomer Candy
*Bob Evans
Cerestar USA, Inc.
Christopher Ranch
Dole
*Donatos
The Garlic Company
Hillshire Farm and Kahn's
Jones Potato Chips
Joy Cone
Lipton
Luigianos
Miller Brewing Company
Nestle
*Pepsi Cola
*Ralston Foods
*Ralston Purina
*Ross Products, Division of Abbott Labs
Sargento Foods
St. Albans Creamery Coop.
Stroh's Brewery
Sunsweet Growers
Tamarack Dairies
*Worthington Foods
Wyeth Nutritionals

FURNITURE

Ethan Allen
Vermont Tubbs

GAS TRANSMISSION

Columbia Gas Transmission
*Consolidated National Gas
Lancaster Gas
National Energy
*Tennessee Gas
Texas Eastern Gas Transmission

GLASS

*Anchor Hocking
Ball Foster Glass
Cardinal Glass
Constar
*Holophane Corporation
Hordis Brothers
Lancaster Glass
Libby Owen Ford
Oasis Mfg
*Pilkington
Premiere Auto Glass
*Saint Gobain Container
Techniglas

HEAVY EQUIPMENT MANUFACTURING / AUTOMOTIVE

Flexible Corporation
*Ford Motor Company
*General Motors Corporation
*Honda of America
IGM, SA, Mexico
International Case
John Deere
Johnstown industries
*Subaru - Isuzu Automotive
*Union Tank Car

HOSPITALS / MEDICAL PRODUCTS

Allegence Health Products
*Bethesda Hospital
Cardinal Health
Childrens Hospital
Ethicon - Endo Surgery
Fairfield Hospital
Grant Medical
Lancaster Hospital
Licking Memorial Hospital
Oral Roberts Hospital
St. Ann's Hospital

INDUSTRIAL / CONSUMER PRODUCTS

Amatek Lamb
Avery Dennisson
Bodine Electric
Bronz Shoe
Cannondale Manufacturing
DAL-Tile
Ebco Oasis
*Ethan Allen
*Eveready Battery
Fiberglass Industries
G.E. Aircraft
*G.E. Lighting
G.E. Turbine
Geka Brush

*Refers to audits at multiple sites of the client.

Table 2-4. List of Compressed Air Audit Clients (cont'd)

Glenwood Range
Golden Cat
Himolene
Hoover Company
Interstate Envelope
Johnson & Johnson
Kodak
*Lancaster Electro Plating
Landis Plastics
Mirro Aluminum
National Manufacturer
*Nestaway
*Paragon Industries
Parker Hannifin
Radiant Color
Ralston Purina
Reynolds Aluminum
Rutland Marble and Granite
Sherwin Williams
Silgan Plastics
Sony
Superior Plating
Sweetheart Cup
Syracuse China
Thermodisc
Thomson Consumer Electronics
Ultramotive
Whirlpool

METALS (MILLS, FOUNDRIES, ETC.)

*ALCOA
*ARMCO Steel
Bethleham Steel
Buckeye Steel Casting
Capstan Atlantic
Cast Master
Central Aluminum
Colfor Manufacturing
Dietrich Industries
Elkem Metals
*General Castings
Hayes Lamerz
Kobe Steel
LTV Steel
Mansfield Foundry
Marion Steel
Metalloy
Met-Tech
Motor Castings
*North Star Steel
Ohio Aluminum
Ohio Steel
Ormet
Pangborn
Republic Steel
Ross Castings
Shield Alloy
Slater Steel
Stolle Products
TFO Tech, Inc.
Timkin Manufacturing
U.S. Steel
Vermont Castings
Vestshell
Wheeling Corrugated Steel
*Wheeling Pittsburg Steel
*Worthington Machine Technology

PACKAGING

*American National Can
*Fabri - Form
*Grief Brothers
*Packaging Corporation of America
*Silgan Container
*Tenneco Packaging

PARTS MANUFACTURING

AY Manufacturing
*Bailey
Daifuku
*Delphi Automotive
Federal Mogul
Fremont Plastics
Glacier Vandervell
Glacier Clevite
ITT Heat Exchanger
ITT Pneumotive
ITW IMPro
*ITW Shakeproof
Kelsey Hayes
Lempco
Nastech
Nisco
Oxford Automotive
Randall Textron
Tiger Poly Manufacturing
Tomasco
TRW Automotive
*TS Trim

PET

Constar
*FarmaPet - Mexico City, Mexico
Johnson Controls
Oasis Mfg.
Owens Brockway
Plastipak Packaging
Schmalbach-Lubeca
Sewell Plastics

PRINTING

Columbus Dispatch
Communicolor
Cyril Scot
Mansfield Printing
Morrow-Macke
Newark Advocate
One Write
Quebecor Vermont

PULP AND PAPER

Fibermark
Fraser Paper
*Georgia Pacific
Irving Tissue
Jefferson Smurfit
Lake Superior Paper
Meade Paper
Ohio Paper Board

REFINERIES

Champlin Refinery
City Service
Texaco

REFRIGERATION PRODUCTS

Lennox
Liebert
Oasis
Showa Aluminum

SKI SLOPES

Bromley Mountain
Stratton Mountain

TEXTILES

Amoco Fabrics and Fibers
*Beaumont Mills
BP Amoco
Queen Carpet
Shaw Industries

*Refers to multiple site audits.

2.8 CCA PROGRAM TIMELINE

Key progress milestones for the CCA Program are provided in Table 2-5.

Table 2-5. CCA Program Milestones

Date	Activity
April 1, 2002	MFO Program kick-off
May 1, 2002	Approval of CCA Program plans: • Outreach plan and descriptive materials • Customer incentive plan • M&V plan Completion and approval of 2 audit reports
May 31, 2002	Approval of EM&V Plan
July 1, 2002	Quarterly Report (2nd Quarter PY 2002) Completion and approval of 12 audit reports
October 1, 2002	Quarterly Report (3rd Quarter PY 2002) Completion and approval of 12 audit reports Installation of 2 projects
January 1, 2002	Quarterly Report (4th Quarter PY 2002) Completion and approval of 12 audit reports Installation of 8 projects
April 1, 2003	Quarterly Report (1st Quarter PY 2003) Completion and approval of 12 audit reports Installation of 10 projects M&V of 10 projects
July 1, 2003	Quarterly Report (2nd Quarter PY 2003) Installation of 10 projects M&V of 10 projects
October 1, 2003	Quarterly Report (3rd Quarter PY 2003) Installation of 10 projects M&V of 10 projects
February 1, 2004	M&V of 10 projects Final Report

3 MANAGEMENT PLAN

3.1 STAFFING

The CCA Program for the CPUC will be managed by John Skelton. John has over 20 years experience designing and implementing technical services for industrial customers. During the past three years he has managed the Vermont, NYSERDA, and PG&E CCA Programs. Each of those programs exceeded savings goals by a significant margin.

Hank van Ormer will serve as one of the two Technical Directors for the proposed CCA Program. Hank filled the same role on the other three CCA Programs and led most of the individual audits, as well. Hank has performed over 300 compressed air audits for clients such as General Motors, Sony, Upjohn, BP Amoco, and Alcoa.

Bill Scales will serve as the other Technical Director for the Program. He is currently co-writing the “Best Practices Guide” for DOE’s Compressed Air Challenge Program. He has led over 300 industrial audits.

Kris Bradley of Quantum Consulting will lead the M&V activities for the CCA Program. Kris has been involved in numerous M&V projects, including industrial, commercial, and residential programs for Pacific Gas & Electric and Florida Power & Light and compressed air projects at Baltimore Gas & Electric, Consumers Power, and Pacific Gas & Electric.

Rich Barnes will serve as XENERGY’s officer-in-charge for the CCA Program. Organizationally, all the XENERGY staff working on the CCA Program belong to XENERGY’s Implementation Division, which is managed by Rich.

A listing of Corporate Qualifications for XENERGY and Quantum Consulting is included in Appendix D. Resumes for key staff are included in Appendix E.

Table 3-1. XENERGY Project Team: Compressed Air Professionals

Hank van Ormer – 30+ years as a compressed air professional – 300+ industrial plant audits – CAC technical advisor and certified Level II instructor – XENERGY Staff	***Bill Scales*** – 30+ years as a compressed air professional – 300+ industrial plant audits CAC technical advisor and certified Level I/II – Scales Air Compressor Staff
Henry Kemp – 30+ years as a compressed air professional – 100+ industrial plant audits – CAC technical advisor and certified Level I/II instructor – XENERGY Staff	***Ernie Wichert*** – 20+ years as a compressed air professional – 10+ industrial plant audits – CAC certified Level I/II training – Scales Air Compressor Staff
Dave Beary – 30+ years as a compressed air professional – 30 industrial plant audits – CAC certified Level I/II training – XENERGY Staff	***Don van Ormer*** – 5 years as a compressed air professional – 30+ industrial plant audits – CAC Level I/II and AirMaster training – XENERGY Staff
Scott van Ormer – 15 years as a compressed air professional – 30+ industrial plant audits – CAC Level I/II and AirMaster training	***Bob Allen*** – 30+ years as a compressed air professional – 10+ industrial plant audits – CAC Level I/II training – Scales Air Compressor Staff

3.2 DISPUTE RESOLUTION

Dispute resolution between XENERGY and participating customers will be handled at four levels:

1. **Prevention** – The CCA Project Participation M-O-U will provide a clear understanding of the role and responsibilities of XENRGY and the customer. The M-O-U is signed by both parties at the time that the project installation contracts and incentive commitments are approved. A Statement of CCA Program and audit purpose and scope are provided to the customer at the onset of the XENRGY site visit.

2. **Discussion** – All disagreements should be resolved at the lowest levels possible within each organization. In this Program, there is a hierarchy of three tiers: XENERGY staff member/Customer staff member at the source of the dispute; XENERGY Program Manager (John Skelton)/Customer project leader; and XENERGY Program Officer (Rich Barnes)/Customer Management.

3. **Mediation** – It is standard XENERGY contractual policy to take any unresolved disputes to binding arbitration.

4. **Protection** – XENERGY carries standard policies for both General Liability Insurance and Professional Liability Insurance.

4 COST PROPOSAL

The budget for the CCA Program is provided in Table 4-1. The financial incentives and audits reflect budgets of $800,000 and $460,000, respectively, or more than three-fourths of the total budget of $1,600,200.

The labor component on the Administrative Cost includes salary, benefits, overhead, G&A, and profit. The estimate for Administrative cost can be low because this is the fourth CCA-type program XENERGY has developed. Travel costs for the different activities (e.g., the audit activity) are included in the line item budget and are not broken separately, except in the case of administrative costs.

The verification and informal process evaluation activity carried our by Quantum Consultants has a budget of $40,000.

The overall budget is split 57% vs. 43% between 2002 and 2003 ($909,864 versus $690,864). The overall budget is split 75% vs. 25% between SCE and SDG&E ($1,200,000 versus $400,200).

Item	First Year Cost	Second Year Cost	Total Cost[1]
Administrative Costs			
Labor	$36,000 (60%)	$24,000 (40%)	$60,000
Benefits			NA
Overhead			NA
Travel costs[2]	$6,000[2] (60%)	$4,000[2] (40%)	$10,000[2]
Reporting costs	$3,000 (60%)	$2,000 (40%)	$5,000
Materials & Handling	$3,000 (60%)	$2,000 (40%)	$5,000
General & Administrative Costs			NA
Subcontractor costs (include same line items)			NA
Marketing/Advertising/Outreach Costs			
Itemized (may be estimated) • Communications/Contacts (200 x $70 each) • Workshops (2 x $5,000 each)	$8,400 (60%)	$5,600 (40%) $10,000 (100%)	$14,000 $10,000
Direct Implementation Costs			
Itemized financial incentives • Customer incentives (2,000,000 kWh x $0.04 per kWh)	$400,000 (50%)	$400,000 (50%)	$800,000
Itemized installation costs			$0
Itemized activity costs • Compressed air reviews – small customers <800 kW (35 x $8K) • Compressed air reviews – large customers >800 kW (15 x $12K)	$178,080 (60%) $144,000 (80%) $ 60,000 (60%)	$101,920 (40%) $ 36,000 (20%) $ 40,000 (40%)	$280,000 $180,000 $100,000

• Project development (50 x $2K)			
Evaluation, Measurement and Verification Costs			
• Performance monitoring (40 sites x $500 per site) • Verification and process evaluation—subcontractor (40 sites x $1000 per site)	$12,000 (60%) $16,000 (40%)	$ 8,000 (40%) $24,000 (60%)	$20,000 $40,000
Other Costs			
Itemized, may include: • Profit or shareholder incentive			
IOU Administrative Fee (%)	$ 43,324	$ 32,876	$76,200
TOTAL BUDGET	$909,864	$690,396	$1,600,200

[1]All costs can be allocated between SCE and SDG&E based on a split of 75% and 25%, respectively, or $1,200,000 for SCE and $400,200 for SDG&E.

[2]Travel costs for the audit team are included in audit fees; for M&V, in the M&V estimates, etc.

A

SAMPLE CCA PROGRAM DESCRIPTION AND DATA COLLECTION FORMS

COMPRESSED AIR SYSTEM EFFICIENCY

“FAST TRACK” – a PG&E Program to Reduce Power Demand
November 17, 2000 (REVISED DRAFT)

PG&E is working with Xenergy, Inc. to help PG&E customers to reduce their power demand before May 1, 2001, the start of the summer peaking season. This particular program focuses on making efficiency improvements in compressed air systems.

WHY COMPRESSED AIR?

Compressed air system improvements can reduce the electric consumption associated with meeting compressed air requirements by 20-40%, where producing compressed air often represents a third of a facility’s overall level of electric use. These potential savings are equivalent to cutting 10% from a firm’s total electric bill – some $50K to $100K for facilities with a total bill in the range of $500K to $1M.

The compressed air saving are normally usually captured through fairly small improvement projects with a simple payback of two years or less.

FAST TRACKING COMPRESSED AIR PROGRAMS

Because we need to get most of the projects up and running by April 30, 2001, the Fast Track program is streamlined and focused on producing results quickly. The program provides a no-cost, no-obligation assessment of compressed air systems – an assessment that will identify specific projects that customers can implement to reduce compressed air costs. The assessment teams are being led by some of the country’s most experienced and practical specialists in compressed air. Moreover, these specialists are not aligned with any equipment brand.

Cutting electric usage in time for the next peak season helps PG&E meet its goals and can give recognition to participating companies for doing their share in helping the Northern California region deal with its electric needs. The catch is we want customers to “self-select themselves.” That is, we want customers to sign up on if they think they:

1. Have some decent opportunities to cut air costs

2. Have the interest and ability to move forward quickly if our assessment yields significant and reasonable opportunities to produce savings.

<u>THIS PILOT PROGRAM HAS ROOM FOR ONLY 8-16 CUSTOMERS TO MOVE FORWARD WITH PROJECTS</u>.

COMPRESSED AIR SYSTEM ASSESSMENT

The plant assessment is the cornerstone of the entire program. It quantifies the potential savings and costs of improvements in the air system. While the credibility of the plant assessment team is critical in giving participants the confidence in the results being delivered, a rigorous measurement process will be implemented to establish the actual level of savings based on a comparison of “before” and “after measurements.

The assessment process begins with collecting a defined set of information prior to the site visit. This information specifically includes:

1. An inventory of current system components (compressors, dryers, filters, etc.) and major compressed air uses

2. A list of key system characteristics (operating pressure, number of production hours, average electric rates, etc.), current system problems, and anticipated system changes.

The plant assessment itself is a two-day site process. Day One consists of a full-day site visit to collect additional data and talk with plant personnel about system operations, problems, and recommendations. Day Two (half of a day) includes follow-up data collection and a presentation of the plant assessment summary. The presentation will conclude with a determination of the customer’s interest, issues, and timetable for moving forward.

PROGRAM BENEFITS

Customers participating in the plant assessments receive:

1. A comprehensive review of their compressed air system including quantification of system operating costs and potential project costs and savings associated with the improvement

2. An action plan for improving their system and resolving outstanding system problems

3. Face-to-face discussions of system assessment results with experienced and independent compressed air experts.

Customers moving forward with implementation receive:

1. Project specifications to help expedite developing contracts with a vendor to implement the project

2. System measurement to establish actual savings achieved on a “before” and “after” basis.

COMPRESSED AIR SITE VISIT:
DATA COLLECTION FORM – AIR SUPPLY AND END USE OVERVIEW

Company Name		Plant Products	Date
Street		Contact/Title	
City State Zip		Contact/Title	
Telephone Number	Fax Number	Contact/Title	

SYSTEM DATA

Min. Operating Press ____________________________ PSIG Max Operating ________________ PSIG

Avg ACFM Demand 1st Shift _________ CFM ___________ Hr/Day _______ Days/Year _________

Avg ACFM Demand 2nd Shift _________ CFM ___________ Hr/Day _______ Days/Year _________

Avg ACFM Demand 3rd Shift _________ CFM ___________ Hr/Day _______ Days/Year _________

Avg ACFM Demand Wkd/Holiday ________ CFM ___________ Hr/Day _______ Days/Year _________

Avg Electric Rate _______ $/kWh Demand charge ________ $/kW Energy Charge _______ $/kWh

Power Factor Rating ______________________________ /Voltage _______________________________

Planned Changes to System: ____

____

____

____

Provide simple drawing of current system and mark any planned changes.

CURRENT EQUIPMENT LIST

Unit 1: Compressor

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Drive _______________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Type of Control ______________________________

Unit 2: Compressor

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Drive _______________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Type of Control ______________________________

Unit 3: Compressor

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Drive _______________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Type of Control ______________________________

Unit 4: Compressor

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Drive _______________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Type of Control ______________________________

Unit 5: Compressor

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Drive _______________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Type of Control ______________________________

Unit A: Dryer

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Pre/Aft Filters _________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Comments ______________________________

Unit B: Dryer

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Pre/Aft Filters _________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Comments ______________________________

Unit C: Dryer

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Pre/Aft Filters _________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Comments ______________________________

Unit D: Other ____________________________

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Pre/Aft Filters _________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Comments ______________________________

Unit E: Other ____________________________

Brand _______________ / Type _______________

Model _______________ / SN# _______________

HP _______________ / Pre/Aft Filters _________

CFM _______________ / PSI _______________

Tank _______________ / AFT _______________

Comments ______________________________

OTHER SYSTEM DATA

1. WATER COOLING – (If Applicable)

   "Well Water" ______________________________ Water Condition __________________________

   "City Water" ______________________________ Water Condition __________________________

   Cost per Gal $ ______________________________ Sewer Charge ____________________________

   "Closed System" ____
   Brand Model Mix

   "Evaporative System" ____
   Brand Model Chemical

COOLING WATER TEMPERATURES/FLOW/PRESSURE:

MAX __________ °F __________ GPM MIN ____________ °F ____________ PSIG

2. AIR COOLING

   Room Size _____________ Air Inlet Size ______________ Air Outlet Size _____________

   Estimated Heat Load (HP) Rejected to Room Now ____

   Comments ____

3. AMBIENT CONDITIONS: General Description of Area and Ambient Air (*Include Surrounding and Inlet Area)*

   ____

   ____

   ____

   ____

   "Presence of Corrosive Material" (What, When, How Far?)

   ____

   "Presence of High Dust/Abrasives" (What, When, How Far?)

   ____

   "Presence of Small Fines"

   ____

   ____

   ____

4. MAINTENANCE SCHEDULE & PROCEDURES: (What Done – By Whom—How Often & Safety Equipment Testing) / Basic Operating Conditions, etc.

   ____

   ____

   ____

   ____

   ____

   ____

   ____

OPERATING CONDITIONS – CUSTOMER STAFF INTERVIEW

Name of Contact ________________________ Name of Contact ______________________

Name of Contact ________________________ Name of Contact ______________________

1. Percent at Full Load / Per Shift ____
2. Pressure Problems in System? Where? When? ____________________________________

   ____

   ____

3. Water/Oil Problems in System? Where? When? What is Using Area? ______________________

   ____

   ____

4. Area There Areas Where Oil Contamination is More Critical? ___________________ Catastrophic?

   ____

5. Is Any of This Air Used for Breathing? ____

   ____

6. Do You Rent Air? _____________________ How Often/Year? ______________________

   - For Emergency? ____
   - For Peak Load? ____
   - Is Your Rental Tie In ❑ Diesel ❑ Electric ❑ Other ❑ Aftercooler ❑ Not Aftercooled
   - Would You Like a Diesel vs. Electric Operating Cost Comparison? ____________________

   ____

   ____

   ____

   ____

   ____

   ____

   ____

7. Do You Use Any of the Following:
   - Infrared Thermal Inspection? ____
   - Vibration Analysis? ____
   - Oil/Lubricant Analysis Program? ____
   - Water Analysis Program? ____
   - Water Gycol Test Program? ____
   - Regular Compressed Air Leak Control? ____________________________________

FOLLOW UP REQUIRED

Item	YES	NO
1. Pressure Loss Analysis/Recommendations ____________________________		
2. Compressor Control/Operating Analysis ______________________________		
3. Power Cost Analysis/Recommendation _______________________________		
4. Total Operating Maintenance Cost Analysis ____________________________		

5. Other ____

____

____

____

____

____

SYSTEM CHECKLIST

Pressure drop: interconnecting piping, dryers, filters

Header pressure/performance

Lowest possible pressure at process

Regulators set	Rest
	Operation
Condensate drains	Manual
	Timer
	Level
Condensate handling	
Cabinet cooler	Air
	Vortex
	Refrig
Blow offs	
Vacuum generator	Brand
	Type
	Auto
Diaphragm pump	Size
	HP
	Controls
Misapplied high pressure air	Sparging, etc.
Heat recovery opportunities	Air
	Water

ESTABLISHING BASIC ENERGY COST

PER CFM/PER PSIG – FULL LOAD

	Model _________________ acfm _________________ fad _________________ psig FL Press _________________ max psig _________________ bhp _________________ Kw
1) Power Rate $ _________ kWh	_________________ kWh
2) Specific power = cfm/kW	Cfm/fad+kW = cfm/kW
3) Power Cost (1) cfm (1) hour = cst/cfm/hr	Cst/cfm/yr x hrs/yr = cst/cfm/hr
4) Cost per cfm/yr	Cst/cfm/yr x cfm flow = cst/cfm/yr
5) Year Estimated energy cost/yr @ full load	Cst/cfm/yr x cfm flow = energy cst/yr
6) Cost per psig/yr (Positive displacement compressors only)	(kW) (.005) (pwr rate) (hrs) = pwr cst/psig/yr

KEY FORMULAS

- ❑ $HP = \frac{(Amps)(Volts)(1.732)(ME)(PF)}{746}$

- ❑ $\text{Input kW} = \frac{(Amps)(Volts)(1.732)(ME)(PF)}{1000}$

Power Rate = $ _________________ /kWh
Prod Hours = _________________ year
Non-prod Hours = _________________ year
Prod Cfm Flow = _________________ cfm
CFM Flow = _________________ cfm

ESTIMATED LOAD PROFILE AND POWER/ENERGY ANALYSIS PLANT AIR SYSTEM

Measure	1st Shift	2nd Shift	3rd Shift	Holidays	Total
Average Production Flow	cfm	cfm	cfm	cfm	cfm
Average Production kW	kW	kW	kW	kW	kW
Production Air Operating Hours	hrs	hrs	hrs	hrs	hrs
Specific Power	cfm/kW	cfm/kW	cfm/kW	cfm/kW	cfm/kW
Energy Cost $ cfm/yr	$ cfm/yr	$ cfm/yr	$ cfm/yr	$ cfm/yr	$ cfm/yr
Estimated Air Energy Cost per Year	$ /yr	$ /yr	$ /yr	$ /yr	$ /yr
Air Energy Cost $ per psig/yr	$ psig/yr	$ psig/yr	$ psig/yr	$ /psig/yr	$ psig/yr

Blended Power Rate: __________ kWh

Controls: ____________________ Estimated Annual Energy Cost: $ _______________ /yr

	Manufacture	% of Load	% of Power	FL kW x % of Power	Net kW
1					
2					
3					
4					
5					

Conditions/Comments

Second Shift

Controls: ___________________ **Estimated Annual Energy Cost: $** _______________ **/yr**

	Manufacture	% of Load	% of Power	FL kW x % of Power	Net kW
1					
2					
3					
4					
5					
6					

Psig _______________ Hours ________________ Total cfm ________________

Conditions/Comments

Third Shift

Controls: ___________________ **Estimated Annual Energy Cost: $** _______________ **/yr**

	Manufacture	% of Load	% of Power	FL kW x % of Power	Net kW
1					
2					
3					
4					
5					
6					

Psig _______________ Hours ________________ Total cfm ________________

Conditions/Comments

Weekend/Holidays

Controls: ___________________ **Estimated Annual Energy Cost: $** _______________ **/yr**

	Manufacture	% of Load	% of Power	FL kW x % of Power	Net kW
1					
2					
3					
4					
5					
6					

Psig _______________ Hours ________________ Total cfm ________________

Conditions/Comments

SYSTEM PRESSURE PROFILE DATA

Customer ______________________ Floor # ____ Scale ___________ Sheet No ___ of ____

Calculated by __________________ Date _____ Checked by _______________ Date ______

TIM E	TAP LOCATION	BUILD-ING	PSIG NOMINAL	FLOAT	COMPRESSOR ROOM
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig
			psig	psig to psig	psig to psig

COMPRESSOR STEP UNLOADING DATA

Customer ______________________ Floor # ____ Scale ___________ Sheet No ___ of ____

Calculated by ___________________ Date _____ Checked by _______________ Date _______

COMPRESSOR	MODEL	CFM	ACT. PRESS.	LOADED /SEC	UNLOADED /SEC
			TOTAL =		
			% OF LOAD =		

COMPRESSED AIR SITE VISIT:
DATA COLLECTION FORM – DETAILED END USE DATA
(DOE COMPRESSED AIR CHALLENGE CHECKLIST)

HIGH END-USE PRESSURE REQUIREMENTS

How are the pressure setpoints on the compressors' controls configured?

	Load	Unload/Modulate
Pressure setting	________________ psig	_________________ psig
Pressure setting	________________ psig	_________________ psig
Pressure setting	________________ psig	_________________ psig

What is the pressure going into the main header?

Pressure __________________________________ psig

What is the end-use pressure required for typical applications in the plant?

Pressure __________________________________ psig

List any applications that require higher than typical pressure

Application	Approximate End-Use Pressure Required
________________________________	___________________________ psig
________________________________	___________________________ psig
________________________________	___________________________ psig
________________________________	___________________________ psig

List any applications that require lower than typical pressure

Application	Approximate End-Use Pressure Required
________________________________	___________________________ psig
________________________________	___________________________ psig
________________________________	___________________________ psig
________________________________	___________________________ psig

List any applications where users complain about low pressure

Application	Approximate End-Use Pressure Required
________________________________	___________________________ psig
________________________________	___________________________ psig
________________________________	___________________________ psig
________________________________	___________________________ psig

Have compressor setpoints been raised to try and compensate for low pressure at
end-use applications? ❑ Yes ❑ No ____

HIGH VOLUME/INTERMITTENT APPLICATIONS

What is the full load output from the compressors in the system?

____________ cfm @ _______________ psig (Summer)

____________ cmf @ _______________ psig (Winter)

List any applications that are for a short duration and use a high volume of air

Application	Approximate Volume Required	Minimum OnMinimum Off
___________	________________________ cfm	_________________________
___________	________________________ cfm	_________________________
___________	________________________ cfm	_________________________
___________	________________________ cfm	_________________________
___________	________________________ cfm	_________________________

Have any steps been taken with the control and storage systems to address these applications?

❑ Yes ❑ No

If yes, describe: ____

____

____

____

____

____

____

____

____

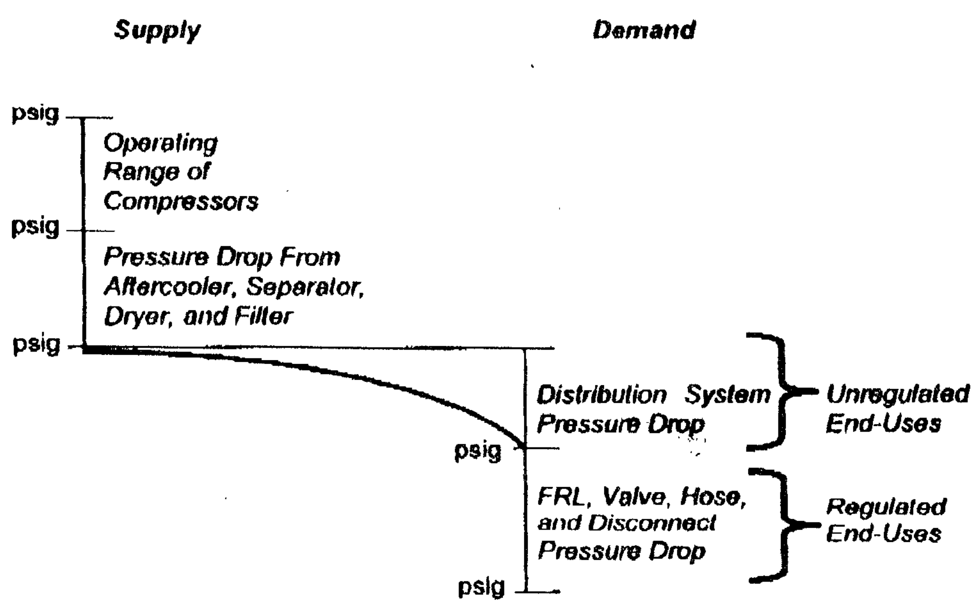
SUMMING END-USE REQUIREMENTS

Use a table like the one presented below to inventory and sum all the end-use requirements.

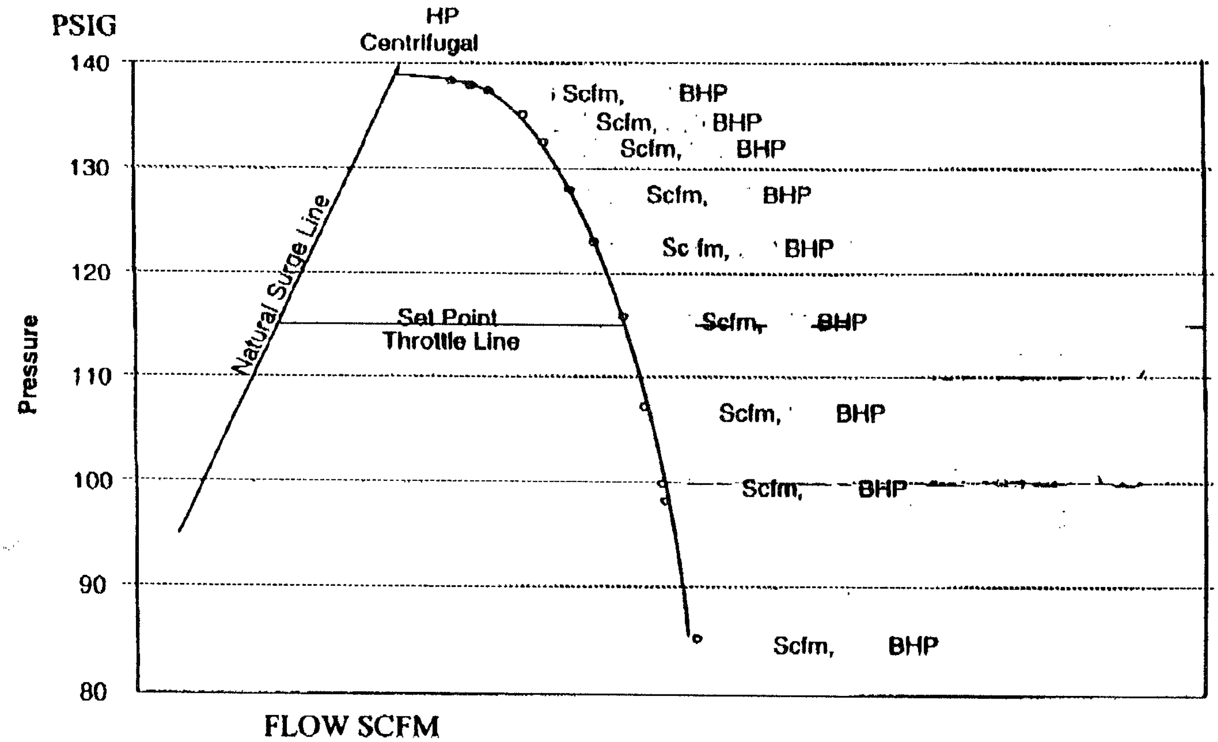
		Original Flow (cfm)			Revised Flow (cfm)	
Operation	Action	Continuous	Average	Peak	Peak	Potential Peak Reduction
TOTAL						

AVERAGE SYSTEM PRESSURE PROFILE

PSIG	Load/Unload	Modulation	Modulation
110			
105			
100			
95			
90			
85			
80			
75			
70			
65			
60			
55			
50			



PERFORMANCE CURVE AND OPERATING BAND PROFILE -- CENTRIFUGAL



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SAMPLE REPORT

ABC Company
Compressed Air System Review: Executive Summary

ABC Company now spends more than $34,600 annually on energy to operate the compressed air system at Anytown, USA. This figure will increase as electric rates are raised from their current average of 11 cents per kWh. The set of projects recommended below could reduce these energy costs by $17,800 or 50%. In addition, the projects will significantly reduce down-time and maintenance costs associated with the air system and will provide critical redundancy within the existing system. Estimated costs for completing the projects total $58,300, which represents a simple payback of 3.3 years on energy savings alone.

PROJECT	SAVINGS PROFILE	ENERGY AND OTHER SAVINGS			TOTAL PROJECT COST ($)
		PEAK kW	kWh	TOTAL SAVINGS ($)	
SUPPLY SIDE REVIEW					
AIR COMPRESSOR SUPPLY					
1. Replace current compressor with more efficient SR Drive.	35% supply system efficiency increase	19	110,000	$12,100	$28,000
CAPACITY CONTROLS					
2. Install 660 Gallon receiver and repipe compressor area.	No direct energy savings, but necessary for capacity control.				$2,700
AIR TREATMENT					
3. Add more effective & efficient compressed air dryer (Note: Current dryer is fouled and not performing) [8]	1.29 kW 9 psig	3.9	21,800	$1,200 $1,200 $2,400 /yr	$8,000
4. Repair aftercooler to correct performance now has 9 psid. Unit to run back up only	Included in Project #1.				
5. Install Mist eliminator and level-activated drains	No direct energy savings, but will improve air quality significantly.				$2,600
DEMAND SIDE REVIEW					
6. Implement an ongoing leak identification and repair program with ultrasonic locators [19]	35 cfm	5.4	30,000	$3,300	$4,600
Project installation costs					$12,400
TOTAL	**9 psig 35 cfm 35% Eff Incr**	**28.3 kW**	**161,800 kWh**	**$17,800**	**$58,300**

It also is important to note that other recoverable compressed air costs should also be considered, i.e., maintenance, water costs, depreciation, etc. Usually, the electric cost is between 75% and 90% of the total “variable compressed air costs.” Associated maintenance and other costs will be, in all probability, at least 20% or more of the identified electric cost.

PROPOSED ACTION PLAN

Install a variable speed drive compressor to handle the demand for production air. Replace the current dryer with a high quality cycling dryer, this will have an energy savings and will help in the overall quality of compressed air supplied to the plant. Install a loose packed deep bed filter ahead of the dryer to eliminate any oil vapor or big slugs of water reaching the dryer. Repipe the compressor are to eliminate any “crossing T’s” and back pressure in the current piping. Install level operated see through type condensate drains, these will remove any oil-water condensate from the supply side system and not let it re-entrain back into the system. Install 660 gallon receiver after the dryer and before entry to plant.

1. Repipe interconnecting piping in compressor area
2. Install a variable speed compressor
3. Replace current non-cycling refrigerated dryer with a cycling dryer
4. Install a loose packed deep bed filter ahead of the dryer
5. Install a 660 gallon air receiver after the dryer
6. Replace and install level-operated, see-through-type condensate drains at all appropriate points
7. Investigate a continuing leak identification, tagging and repair program.

OTHER INVESTIGATIONS OR LONG-TERM STRATEGIES

1. Investigate installing electric ball valves prior to press machines to shut off air when process is not in use
2. Investigate operation of use of cabinet coolers either refrigerated or pneumatic
3. Look of installing Venturi amplifiers on all blow guns
4. Make sure Venturi vacuum generators have automatic shut off controls and that they are working properly
5. Check that air operated diaphragm pumps are running at the lowest effective pressure
6. Look at ducting hot cooling air from the compressor to heat areas of the plant.

COMPRESSED AIR SYSTEM REVIEW

Prepared for:

ABC Company
Anytown, USA 12345

Prepared by:

Xenergy, Inc.

January 14, 2002

*Disclaimer: This report provides a general overview of the facility's compressed air system. As such, all data and analysis presented are estimates and should be only considered as guidelines. Final project specification and enumeration of potential savings and costs should be developed using appropriate compressed air system professionals. Cost and savings estimates and "totals" included in tables may have been rounded.

TABLE OF CONTENTS

CHAPTER 1. COMPRESSED AIR SYSTEM REVIEW – OBJECTIVES

The REPORT SECTION of the Compressed Air System Review identifies specific measures to reduce air usage. These reductions usually translate into lower electric costs, improved system operation, and enhanced productivity and quality. For a summary of results for this section, refer to the EXECUTIVE OVERVIEW at the front of this notebook.

For details of data gathered and work sheets completed, refer to the PLANT SURVEY SECTION of the notebook. For equipment performance and details, see the EQUIPMENT SECTION. For reference cost for measures, refer to the PROJECT COST SECTION. For additional information and articles, see the MISCELLANEOUS SECTION.

The primary objective of the review is to provide a comprehensive list of specific measures needed to lower or improve overall compressed air efficiency in the short- and long-term.

This review also addresses other related topics:

- Review appropriateness of major equipment pieces in the compressed air system to produce the right quality and quantity of usable compressed air at an acceptable efficiency
- Develop a load profile of compressed air production
- Identify current electric power cost per cfm and per psig in order to establish a baseline for evaluating potential measures
- Review the benefits, if any, of an alternate back-up or trim unit or techniques to serve local system higher pressure demand — e.g., small compressor, booster, or amplifier
- Identify opportunities and savings in lowering compressor discharge and header pressure to improve production, productivity, and quality
- Outline plans for an ongoing leak management program
- Identify savings potential in use of air saving devices such as nozzles and auto drains
- Identify critical areas to utilize planned storage in the system:
- Estimate benefits of recommended savings measures, including reduced electric consumption and maintenance costs and improved productivity and system operation.

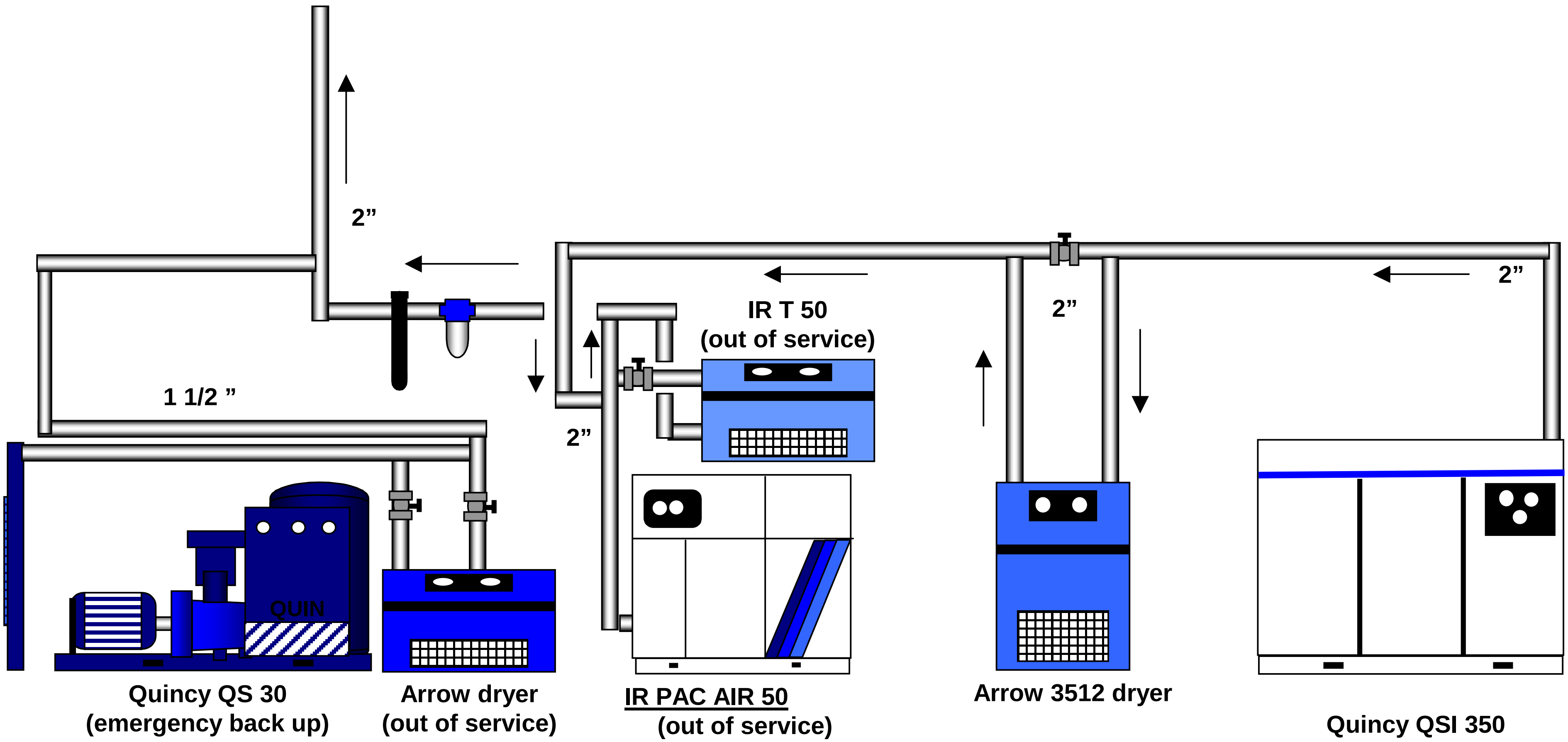
CHAPTER 2. CURRENT SYSTEM REVIEW

2.1 BACKGROUND

ABC Company is an established company in the widget-making industry. Production has expanded over the years with the expansion of sales, and the compressed air supply has had to be increased to meet production demand. Figure 1 provides a schematic of the current compressed air system at ABC Company's Anytown, USA facility.

The company started out with an Ingersoll-Rand Pac Air 50 Compressor, then they added a Quincy Q530 to handle the extra load. They then installed a Quincy QSI350 compressor that they now run base load and use the Quincy Q530W as back up. The I-R is out of service and is not used at all.

Figure 1. ABC Company: Current Air System



2.2 CURRENT SYSTEM BASELINE

Summarized below are the key characteristics describing the performance and economics of the current compressed air system. Tables 1 and 2 were developed based on the data collected during the site visit and with discussions with plant personnel. The estimates are conservative and reflect observed performance of each compressor compared to load cycle. (Refer to the worksheets in the PLANT SURVEY SECTION for calculation details.)

Table 1. Key Air System Characteristics – Current System*

Measure	1st Shift	2nd Shift	Saturdays 80% of Full Load	Total
Average System Flow (cfm)	266 cfm	88 cfm	205 cfm	N/A
Average Compressor Discharge Pressure (psig)	115 psig	125 psig	115 psig	N/A
Average System Pressure (psig)	97 psig	112 psig	97 psig	N/A
Input Electric Demand (kW)	61 kW	52 kW	56 kW	N/A
Operating Hours of Air System (hrs)	2500* hrs	2500* hrs	576** hrs	5,576 hrs
Specific Power	4.36 cfm/kW	1.69 cfm/kW	3.66 cfm/kW	N/A
Electric Cost for Air – per unit of flow ($/cfm/year)	$63.07	$162.72	$16.76	$242.55
Electric Cost for Air – per unit of pressure ($/psig/yr)	$83.86	$71.50	$17.70	$173.06
Annual Electric Cost for Air ($/yr)	$16,775	$14,300	$3,548	$34,623

*Based on a blended electric rate = $0.11 kWh per kWh.

**Hours based on year 2000 production levels. These data were provided by plant personnel.

Table 2. Compressor Use Profile – Current System

Unit #	Compressor – Manufacturer and Model	Percent of Load	Percent of Power	Full Load kW x Percent of Power	Net Demand (kW)	Actual Flow (cfm)
First Shift: Operating at 266 cfm and 97 psig						
1	Quincy QSI 350	70%	92%	66 x .92	61	266
Second Shift: Operating at 88 cfm and 112 psig						
1	Quincy QSI 350	25%	78%	66 x .78	52	88
Saturday's Operating at 205 cfm and 97 psig						
1	Quincy QSI 350	54%	85%	66 x .85	56	205

Summary

Current electric rates at the plant average $0.11 /kWh. The actual plant electric cost for air production, as running today, is probably in excess of $34,600 per year.

The load profile or demand of this system is not relatively stable during all shifts. The full load operating range is 250 days a year, 20 hours a day and 5,000 hours a year for the first and second shifts. The full load operating range for Saturday shifts is 48 days a year, 12 hours a day, 576 hours a year. There are no flow meters in the system.

The system pressure appears to run from 95 to 100 psig in the headers during first shift and 112 psig during the second shift.

2.3 PROPOSED SYSTEM BASELINE

Summarized below are the key characteristics describing the performance and economics of the proposed compressed air system. Tables 3 and 4 are modifications of similar tables displayed previously that described the current system. The tables were modified to reflect the system performance and operating cost changes resulting from implementing the set of projects recommended in this report.

Figure 2 provides a schematic of proposed compressed air system changes at ABC Company's Anytown, USA facility. The tables reflect the following changes to the current system:

Pressure Reduction – total pressure reduction by shift = 9 psig

- Reduce pressure loss of 9 psig by replacing fouled dryer.

Flow Reduction – Total flow reduction = 35 cfm by shift

- Leak Repairs – 35 cfm

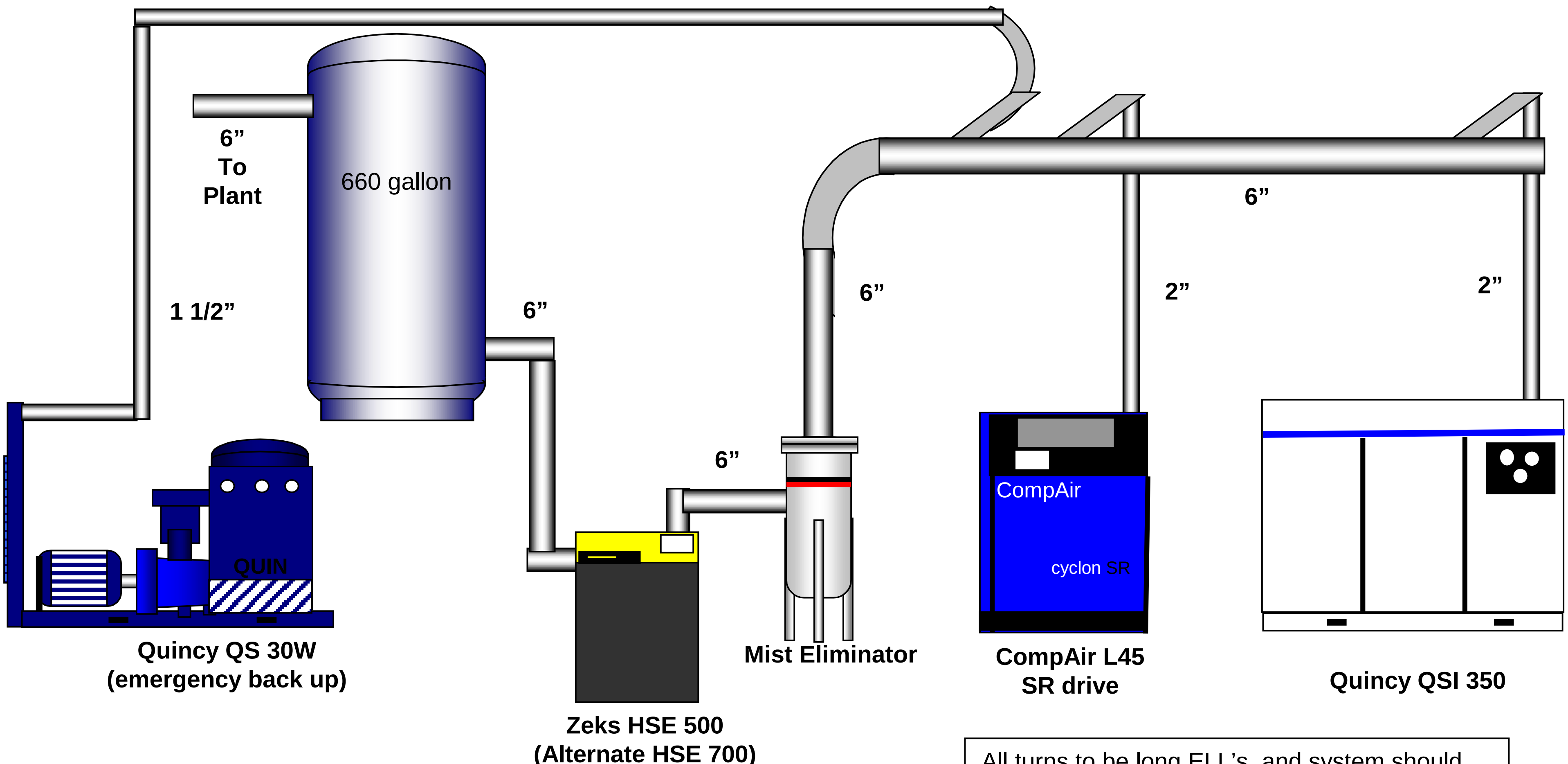
Supply System Efficiency

- Install a smaller, variable speed compressor – 35% supply system efficiency improvement

Other projects or savings not reflected in the tables include:

- Dryers - $1,215
- Install Mist Eliminator

Figure 2. ABC Company: Proposed Air System



All turns to be long ELL’s, and system should be piped according to local codes. Diagram is for schematic only. Directional entries to be 30^{o} or 45^{o} at most.

Table 3. Key Air System Characteristics – Proposed System*

Measure	1st Shift	2nd Shift	Saturdays	Total
Average System Flow (cfm)	231 cfm	53 cfm	170 cfm	N/A
Average Compressor Discharge Pressure (psig)	98 psig	98 psig	98 psig	N/A
Average System Pressure (psig)	95 psig	95 psig	95 psig	N/A
Input Electric Demand (kW)	46.4 kW	11.6 kW	33 kW	N/A
Operating Hours of Air System (hrs)	2,500 hrs	2,500 hrs	576 hrs	5,576 hrs
Specific Power	4.97 cfm/kW	4.56 cfm/kW	5.15 cfm/kW	cfm kWh
Electric Cost for Air – per unit of flow ($/cfm/year)	$55.33 psig / yr	$60.30	$12.30	$127.93 cfm / yr
Electric Cost for Air – per unit of pressure ($/psig/yr)	$63.80 psig / yr	$15.95	$10.45	$90.20 psig / yr
Annual Electric Cost for Air ($/yr)	$12,760 /yr	$3,190 / yr	$2,090 / yr	$18,040 /yr

*Based on a blended electric rate = $0.11 per kWh and variable speed controls.

Table 4. Compressor Use Profile – Proposed System

	Compressor – Manufacturer and Model	Percent of Load	Percent of Power	Full Load kW x Percent of Power	Net Demand (kW)	Actual Flow (cfm)
All Shift: Operating at 231 cfm and 95 psig						
1	Compair L45SR	80%	82%	58 x .82	46.4	231
Second Shift: Operating at 53 cfm and 95 psig						
1	Compair L45SR	19	20	58 x .20	11.6	53
Saturday Shift: Operating at 70 cfm and 95 psig						
1	Compair L45SR	60	57	58 x .57	33	170

Project Savings Summary

The savings potential of the projects related to changing the use of the compressors total $17,800. In addition, the projects will significantly reduce down-time and maintenance costs associated with the air system and will provide critical redundancy within the existing system. Estimated costs for completing the projects total $58,300, which represents a simple payback of 3.3 years on energy savings alone.

Some of the key parameters characterizing the current and proposed systems and the associated savings projects is provided below.

System comparison:	Current System	Proposed System
Average flow	1st – 266 cfm 2nd – 88 cfm 3rd – 205 cfm	1st – 231 cfm 2nd - 53 cfm 3rd – 170 cfm
Average compressor discharge pressure	115 psig	98 psig
Average system pressure	100 psig	95 psig
Electric cost per cfm	$242.55	$127.93
Electric cost per psig	$173.06	$ 90.20
Annual electric cost	$34,600	$18,000

Overall project evaluation:	Savings	Costs
Compressor Operations	$12,100	$28,000
- Run smaller, more efficient compressor with SR drive		
- Repair leaks	$ 3,300	$ 4,600
Other System Components		
- Replace fouled dryer and run cycling refrigerated dryer	$2,400	$ 8,000
- Repipe compressor room and old receiver		$ 2,700
- Install mist eliminator		$ 2,100
- Install level-activated drains		$ 500
Repiping & installation	Will have steady 95 psig pressure – non-fuels as low as 84 psig	
TOTAL SAVINGS	$17,800 /yr	
TOTAL COSTS (including installation)	$58,300	

2.4 PROJECT EVALUATION SUMMARY

This report identifies the "electric cost per hour per loaded cfm" of air used. Electric cost was selected as the key project evaluation factor, since it is a good overall indication of system costs and savings associated with potential measures. It is an absolute number and not a subjective opinion -- i.e., if the compressed air is used, these dollars are spent. All paybacks are estimated using the "Full Load Operating Efficiencies", which are very conservative.

If the compressed air is not used, the compressor either shuts off or unloads. If it shuts off, there is a 100% saving of the electric cost. If it unloads, there is a 25 to 90% savings.

The remaining two chapters identify and evaluate the specific projects that together make up the overall project costs and savings listed previously. In order to provide a reasonable value to the savings generated by each of the projects, a methodology is used to determine the "$ per psig" for pressure reduction projects and the "$ per cfm" for flow reduction projects. Such a methodology is motivated, in part, by seeking to avoid any potential double-counting of savings streams – a prevalent mistake in some energy assessments.

The methodology is based on an allocation, which means that if a parameter is set too high for one type of project (pressure reduction projects vs. flow reduction projects), it would be set too low by a proportional amount for the remaining project type. Although this factor could influence the economics of any single, it doesn't impact the economics of the aggregate set of projects. In any case, it almost always recommended that the entire set of projects be implemented, because many of the projects are interactive in nature and leaving out a single project could eliminate the effectiveness of the other projects that were kept.

Parameters are first established for estimating the savings associated with making the supply system more efficient – i.e., adding a smaller, variable speed compressor unit. This estimate is based on comparing in percentage terms the relative efficiency of the current system and the new system, usually on a cfm per kW basis. For this project, the efficiency improvement is close to 35% or $12,100.

Reductions in system pressure translate directly to savings in system operation. For the purposes of this report, the value of such projects is set at the average of the "$ per psig" figures for the "Current System" and "Proposed System" (from Table 1 and Table 3 respectively) or $127.81. The product of this valuation figure and the total level of pressure reduction yields the sum of the savings associated with all pressure reduction projects or $1,150.29.

Reductions in system flow do not directly translate into energy savings, because compressor efficiency decreases as the operational level (expressed as a percent of full load) decreases. For air systems with good unloading controls and piping, approximately 60 to 80% of the potential level of savings from flow reduction projects can be captured or recovered. For this report, the total flow reduction is 35 cfm. The "$ per cfm" figure used to evaluate individual projects is simply the total savings from flow-related projects ($3,300 or that portion of the total system savings not already allocated to efficiency improvement or pressure reduction projects) divided by the total flow reduction in cfm or $185.17 per cfm.

CHAPTER 3. SUPPLY-SIDE SYSTEM REVIEW

3.1 PRIMARY AIR COMPRESSOR SUPPLY

The primary compressor is a Quincy QSI350, 75-hp class, single-stage, lubricant-cooled rotary screw compressor with an air-cooled aftercooler. It delivers 355 acfm at 110 psig. There is a Quincy QS30W 30-hp class, single-stage, lubricant-cooled rotary screw compressor equipped with an air-cooled aftercooler. It produces 122 cfm at 100 psig. This compressor is run only for emergency back up.

The primary compressed air supply is produced by relatively efficient air compressors that are capable of delivering the 110 psig full load pressure in a continuous manner. The units are well applied. They appear to be in good operating order and well maintained. Key characteristics of the units are summarized in Table 5.

Table 5. Comparison of Current and Proposed Compressors

Type	SS Lubricant-cooled Rotary Screw	SS Lubricant-cooled Rotary Screw	SS Lubricant-cooled Rotary Screw with Variable Speed
Brand	Quincy	Quincy*	Compair
Model	QSI 350	QS30W	L455R
ACFM	355	122	280
FL Press	110	110	100
kW @ 110 psig	66	28.6	58 @ 100 psig
Cfm/kW/110 psig	5.37	4.26	4.82
Annual Elec Cost $/cfm	$114.21	$143.98	$127.25**
Annual Elec Cost $/psig	$202.40	$87.71	$177.87

*Back up only.
**At full load.

☑ **RECOMMENDED PROJECT (#1-1) –** Install a Compair L455R variable speed compressor to handle the base load demand of the plant. This machine runs very effectively and efficiently in the range of the new lower system demand.

We also recommend changing the controls on the Quincy QSI350 to load/no load with auto start/stop. This will allow it to be used as a trim machine when and if the loads increase higher than the capacity of the new compressor. With the auto start/stop feature, it will turn on and load in for as long it is needed, then blow down, idle, and then shut off.

Annual electrical cost to run current system	\$34,623
Annual electrical cost to run new compressor	\$18,040
Total annual electrical energy savings	\$16,600
New variable speed compressor (Compair L45SR) (equipment only)	\$28,000
Installation costs	\$1,500
Total costs	\$29,500

3.2 COMPRESSOR CAPACITY CONTROLS

The two most effective ways to run air compressors are at “Full Load” and “Off.”

Capacity controls are methods of restricting the output cfm delivered to the system, while the unit is still running. This is always a compromise and is never as efficient as full load on a specific power (cfm/hp) basis. For details on unloading, see the MISCELLANEOUS SECTION.

Rotary Screw Controls

The two most common controls used are modulation and online/offline. Modulation is relatively efficient at very high loads—and inefficient at lower loads. Online/offline controls are very efficient for loads below 60%, when properly applied with adequate time for blow down. There are several other control types (e.g., “rotor length adjustment” or “variable displacement” and “variable speed drive”) that have very efficient turn down from 100% load to about 60% load.

These controls must be installed correctly to operate efficiently. Piping and storage should be available close to the unit with no measurable pressure loss at full load to allow the signal to closely match the air requirements.

The current system has modulation with blow down and idle with auto start/stop.

The units involved have capacity controls capable of translating “less air used” into a comparable reduction in electric cost. These controls will not work effectively with your current piping and air receiver storage situation.

☑ **RECOMMENDED PROJECT (#4)** – Correct capacity control operation or selection.

The unloader on the QSI350 compressor appears not to be working properly. When we tried to get the machine to unload, the panel gauge went to 155 psig before the safety valve on the sump tank opened. The machine never unloaded. This should be repaired by a qualified compressor company.

3.3 ADEQUATE EFFECTIVE STORAGE FOR CAPACITY CONTROLS

The normal operating band of your compressed air supply is 15 psig. The effective storage capacity is created by the location where this band is neutralized (i.e., 10 psig operating pressure band is neutralized at the point where the 10 psid is utilized to get through the interconnecting piping, dryer, fillers, etc. to the system).

The current system's operating band of 15 psig is neutralized at the dryer. This provides an estimated effective storage volume of .5 cu ft.

This is apparently unsatisfactory to allow the system to run effectively and efficiently.

☑ **RECOMMENDED PROJECT (#2-5,7)** -- Establish effective storage with a 660-gallon receiver and eliminate excessive presure loss between compressor discharge and system.

Install 660-gallon air receiver at dryer discharge piped approximately as shown in Figure 2 in PLANT SURVEY SECTION.

The audit team took pressure readings of the following locations in the compressor room:

- After the sump tank
- Compressor entry to 2" header
- System entry.

We experienced a 19 psid from the sump discharge to the system entry point when the system demand was at is highest. This pressure drop fell when system demand fell, because of the low flow through the aftercooler and the dryer.

We recommend repiping the compressor area with a single 6" header with the machines tied in with a 30° or 45° angled directional entry at the top of the header. This 6" can be run to the mist eliminator and then to the dryer and the receiver tank.

The current 2" pipe with the new flow of 266 cfm would have a pipe velocity of 45 fps. We strive for velocities of 20 fps or less. With the new 6" header, the velocity would be 3 fps and if you had to run all three machines, the two Quincys and the new Compair, the total volume would be approximately 757 cfm with a velocity of 9 fps. This will allow and contaminants to fall out at the low spots; i.e., receiver tank, and not go downstream to the plant.

NOTE: The two filter units after the dryer don't have any filter elements in them. However, while using an ultrasonic leak detector, we could hear noises coming from the empty filter bodies, such as scale being blown around inside. We could not measure the pressure between discharge of the dryer and the discharge of the filters. This could be part of the pressure drop from the compressor discharge to the system entry point.

There will be no electrical energy saving from this project, because plant personnel will be running the new machine. With the new components and piping in place, the current pressure loss should be reduced to approximately 1-3 psid. This will allow your distribution system to remain relatively stable, meaning the current system float of approximately 19 psig (system pressure during production read as low as 95 in most areas to 114 psig during breaks and other non-production times).

Eliminate excessive pressure loss of 18 psid. Measure includes aftercoolers, interconnecting piping, dryers, filters, etc. Modify interconnecting piping as shown on sketch in Figure 2.

PSID	Aftercooler (will only run as back up)	
	- 9 psid savings otherwise	0 psid
	Dryer & filter canisters	9 psid
	Total	9 psid
	Savings valve (Section 2.4)	$127.81 per psid
	Energy savings not to produce 18 psid	$1,200 /yr*
	Estimated dryer cost (not including installation)	$8,000
	Estimated receiver cost (not including installation)	$2,700

*The aftercooler savings will only occur if the current unit continues to run. If the new SRD unit is installed, the only actual savings would be the dryer – 9 psig = $1,200. (See DRYER Section).

3.4 AIR TREATMENT AND AIR QUALITY

3.4.1 Dryers

Current Drying Operation

The current drying is accomplished by an Arrow Model 3512, non-cycling, refrigerated dryer. It will produce a 35°F PDP at 100 psig, 100°F inlet air temperature and 100°F ambient.

There is an apparent 10-15 psig loss through the dryer at high loads. The normal pressure loss at full capacity is around 5 psig. We believe that the air dryer is full of rust, scale, and/or varnish from the compressed air entering the dryer.

An overview of the system's current drying system is shown in Table 6.

Table 6. Comparison of Current Dryers

Type	Non-Cycling Refrigerated
Brand	Arrow
Model	3512
Rating in scfm @100°F; 100 psig	340
SCFM Purge	NA
Est Annual Electric Cost of Purge	NA
Heater kW/Refr kW	2.01
Annual Operating Electric Cost for Current Dryers	$1,937
$ cfm (Rating)	$5.69
Actual Pressure Loss	10
Annual Electric Cost to Produce psig Lost	$838

Refrigerated dryers require a refrigeration system to mechanically cool the air. The lowest possible consistent pressure dew point with a non-cycling dryer is +40ºF. Cycling dryers not only save power (60-75%), but also can deliver a lower pressure dew point (down to 35-38ºF).

The primary dryer is a two-stage, non-cycling, good quality, refrigerated dryer capable of delivering a consistent +40ºF PDP when:

- Air is delivered to the dryer at no more than 100ºF

- The condensate driven out of the aftercooler, prefilter, dryer, and afterfilter is immediately removed from the system and not allowed to re-entrain or build up
- Dryer is not overloaded in volume (scfm).

☑ **RECOMMENDED PROJECT (#3-8)** – Add more effective or efficient compressed air dryer.

We recommend replacing the current compressed air dryer with a good quality cycling refrigerated compressed air dryer with low pressure drop. This cycling-type dryer will probably run the compressor about 20-25% of the time, compared to the compressor o the current dryer running all the time (8,760 hours/yr).

Cost to run current dryer = 2.01 kW x .11 x 8,760	$1,937 /yr
Cost to run new cycling dryer = 3 kW x .11 x 8,760 x .25	$722 /yr
Annual electrical savings	$1,200 /yr*

*Savings does not reflect savings of $1,200 from pressure loss reduction from previous section.

<u>Aftercoolers</u>

Aftercoolers are air cooled and appear incapable of delivering 100°F or lower temperature compressed air to the dryer. During our visit, the ambient room temperature in the compressor area was 76°F. The air temperature of the compressed air at the discharge of the aftercooler was 101°F. This indicates a problem with the ducting or operation of the aftercooler. We recommend that a qualified compressor repair company repair or replace the aftercooler on the Quincy QSI350 compressor, along with having a qualified HVAC engineering company design the appropriate ducting for the aftercooler discharge air.

<u>Water or Oil Carryover in System</u>

Water (condensate) and oil carryover problems in the current air system are significant and can be expected to increase in magnitude during the summer.

The correct way to eliminate water and oil in the air system is to clean and dry the air immediately after it is produced in the compressor room. Then clean dry air can be stored in a separate air receiver and flow it to the system, as required. Some guidelines for controlling oil and water carryover include the following:

1. Generally, it is best to eliminate the water and oil at the air source before it enters the air system

2. Every 20ºF increase in temperature doubles the “moisture load” the compressed air will hold.

3. Compressed air dryers are usually capacity rated with 100ºF, 100 psig inlet air conditions. At 120ºF, 100 psig, the dryer’s capacity rating is reduced 50%.

4. Putting “dry/or oil free” air into system 90% of the time and then allowing wet/oily air in sporadically 10% of the time will, in reality, make the system wet or oily all the time. The liquid water and/or oil will fall out in the piping system continuing to “re-entrain” and contaminate and/or collected in the “low spots” of the system; thus, recontamination as it is pulled into the flowing compressed air system. A wet/oily system may well take many months of continued flowing of clean dry air to “clean up.”

3.4.2 PRE-FILTERS AND AFTER-FILTERS

Pre- and after-filters are generally either particulate or coalescing type and their use depends on the type of dryer in use and various installation considerations.

Desiccant dryers always require a high-quality coalescing prefilter to keep liquid oil and water out of the drying tower. They also always require an effective particulate filter after the dryer to keep "desiccant dust" from migrating into the system.

Refrigerated dryers may or may not need pre and after filters depending on the piping, type of compressor, and desired degree of cleanliness. If the inlet air is apt to be dirty and fouled with carbon scale, etc., a particulate prefilter is called for. If it is liable to have significant liquid or heavy oil mist, a coalescing (or combination coalescing particulate) pre filter may be needed. If oil/water mist is leaving the dryer, a coalescing after filter may be in order.

Care in selection must be taken in all cases because:

- Wasted air pressure costs energy dollars
- Wasted air pressure neutralizes the operating pressure band early
- Standard coalescers will usually not perform effectively at flows much below 20 percent of their rated capacity
- Standard coalescers life will be significantly shortened by particulate load
- Loose-packed, deep-bed mist eliminators (those with correct elements) will coalesce effectively throughout the total scfm range
- Loose-packed, deep-bed mist eliminators (those with correct element) have very high particulate load capability.

There are no pre- or after-filters in your system. According to plant personnel, both of the filter bodies after the dryer have had the elements removed. Therefore, your current system has no filtering capability, except where you have individual filters on your process machines.

If these filters are not coalescing-type filters, you are sending compressor lubricant to the process. This lubricant will also plug a particulate filter and cause a pressure drop across the element.

☑ **RECOMMENDED PROJECT (#4-11)** – Install a loose-packed, deep-bed filter. Specifically, before the refrigerated with a loose-packed deep-bed filter with an estimated 5 to 10 year life, 1 psig or less pressure loss when new—change at 3; .5 ppm oil carryover nominal rating; .5 micron particulate filtration.

With a loose-packed deep-bed prefilter for the refrigerated dryer, this will eliminate compressor lubricant from entering the dryer and coating the heat exchangers. This will allow the dryer to operate more effectively and efficiently, to deliver a more consistent favorable dew point.

Cost of mist eliminator with .5 to 1 psid = $2,100.

While there are no direct energy benefits, air quality will improve significantly.

3.4.3 AUTOMATIC CONDENSATE DRAINS

Background

Automatic drain traps come in three categories: Level-operated mechanically activated, dual timer electronic, and level-operated electronic drains.

Level-Operated Mechanically Activated Drains

Level-operated mechanically activated drains do not waste air, but are prone to clogging and require continuing maintenance to assure operation. These drains work best in a "Power House Situation" where continuing regular attention is part of the system. Drain prices range from $65.00 each to $250.00 each.

Dual Timer Electronic

Dual timer electronic drains use an electronic timer to control the number of times per hour it opens and the duration of the opening. The theory is that you adjust the times to be sure to fully drain the condensate and minimize the open time without water, which wastes compressed air. The reality is that the cycles either don't get reset from the original factory settings (which causes condensate build-up in the summer) or they get set wide open and not closed down later in cooler weather thus wasting more air. When they fail "stuck open", they blow at a full flow rate of about 100 cfm.

Consider that the usual "factory setting" is 10 minutes with a 20-second duration. 1500 scfm of compressed air will generate about 63 gallons a day in average weather or 2.63 gallons per hour. Each 10-minute cycle will have .44 gallons to discharge. This will blow through a ¼ " valve at 100 psig in approximately 1.37 seconds. Compressed air will then blow for 18.63 seconds each cycle, 6 cycles a minute will equal 111.78 seconds per hour of flow or 1.86 minutes per hour of flow. A 1/8" valve will pass about 100 cfm. The total flow will be 100 x 1.86 = 186 cubic feet in 1 hour or 186 $\div$ 60 minutes = 3.1 cu ft/min average.

Depending on the type of discharge valve (whether it is solenoid-operated or motorized ball valve-operated and whether its type of timer is dual with test button or remote alarm), these valve prices range from $89 to 425 each.

Level-Operated Electronic Drains/Pneumatic Drains

Level operated/electronic drains come in a number of varieties, including ones that receive the signal to open from the condensate high level and the signal to close from the condensate low level. These waste no air and from a power cost standpoint, are the best selection and their reliability is usually many times greater than the level operated mechanical. Prices on these range from $250 to $850 for Standard Products (more for specials).
Current Application

The configuration and performance of condensate drains in the plant's compressor are do need to be modified.

The automatic condensate drains currently all go through closed lines to a single 3/8" hose to collection drums. The drain on the dryer is level activated and the drain on the compressor aftercooler separator is level activated.

☑ **RECOMMENDED PROJECT (#5-12)** – Replace all bucket-type drains with level activated drains.

We recommend installing see-through, level-activated, electric-actuated drains at the following locations:

- Air compressor separator – locate outside of compressor enclosure for ease of maintenance and easy observation of operation
- Refrigerated dryers should have two separate drains – one at the precooler and one at the separator. These should <u>not</u> be tied to one common automatic drain.

Be sure auto drains are set up to work effectively. Some examples are:

- Drains should not be tied together to a common header
- Be sure all drains can be checked easily for operation
- Be sure all drains are properly "vented."

Level-actuated, see-through drains should be installed at the following locations:

Connect each drain's point (after-cooler, pre-filter, dryer, after-filter, receivers, and all risers) separately to individual level-activated electric or pneumatic drains to collect and direct the condensate to a proper handling point carry it in a large plastic vented line (4" or 6"). Be sure maintenance personnel can effectively and visually monitor the drain's action.

Equipment cost for the project is $500. There are no energy savings associated with the project.

CHAPTER 4. DEMAND-SIDE SYSTEM REVIEW

4.1 BASIC SYSTEM HEADER AND PIPING

It is the job of the main header system to deliver compressed air for production use from the compressor area to all sectors of the plant with little or no pressure loss—with 1-3 psig being a reasonable target. It is also desirable that the compressed air velocity in the main headers be kept below 20 fps to allow effective drop out of contaminants and to minimize pressure losses caused by excessive turbulence. The magnitude of the turbulence effect also depends on piping design and layout In several areas of the plant. This should be investigated in a Phase II program to determine the proper pipe size and location to eliminate any pressure drop problems that you have.

We observed during our visit that the main distribution header does not form a complete loop around the production areas. There were several areas that the air to a process was fed through small pipe.

Headers were checked at appropriate points with a single test gauge and there is a pressure loss. Subsequently, we believe that your header system today cannot deliver the required air to any area without any significant pressure loss.

☑ **PHASE II INVESTIGATION (#14)** – Correct main distribution header piping.

4.2 MINIMUM EFFECTIVE SYSTEM PRESSURE

There are additional direct power cost savings if you can continue to lower the overall system operating pressure. A steady delivered pressure to the system will allow follow up programs at each process to establish the lowest effective pressure. This will enhance productivity, quality, and continue to lower air usage.

The cornerstone of any effective demand-side air conservation program is to identify and operate at the lowest acceptable operating pressure required at various sectors and operating units in the plant. This should be a continuing program and part of any training awareness procedures.

Regulator Usage

Some regulators are probably set at higher than necessary feed pressure to the process, with some wide open to full header pressure. Key questions to consider include: is there a minimum effective pressure at operation established at the unit for each product run?; and if so, is it being adhered to?

In this type of operation, it is very important that the actual inlet pressure to the process be known and that the lowest effective pressure be held steady for the proper product quality. Installation of storage bottles downstream of the regulator may be needed to "close up" the pressure readings at rest and at operation.

☑ **PHASE II INVESTIGATION (#16)** – Modify regulators and regulated flow at process.

4.3 COMPRESSED AIR CONDENSATE HANDLING

In reviewing the condensate handling system, we understood that the condensate goes to water treatment. If this is true, and discharge condensate meets the requirements of the water treatment facility plant, there is no problem.

Refer to the Article Reprint – “Do You Know Where Your Condensate Is?” in the MISCELLANEOUS SECTION.

However, if the plant is discharging the condensate to a storm sewer or in some other manner to ground water (Federal EPA minimum is 10 ppm) or are required to separate it by your local water treatment facility, we believe this should be discussed in detail.

Estimated cost for an oil/water separator for condensate disposal is $1,800.

4.4 LEAK IDENTIFICATION AND REPAIR

With a plant of this type, an effective leak control program could save 35 cfm or the equivalent of repairing 35 leaks averaging 1 cfm each. On a percentage basis, this leak level is then about the same as leak levels in other plants. Leaks totaling 35 cfm translate into an annual loss of $8,489 in electric cost. A comprehensive leak management program could reduce such levels by 80% or $6,791 annually in recoverable energy dollars.

☑ **RECOMMENDED PROJECT (#6-19)** – Implement a continuing leak identification and repair program with ultrasonic locators.

There should be an ongoing program in place. Generally speaking, the most effective programs are those that involve the production supervisors and operators in a positive manner working in concert with the maintenance personnel. Accordingly, it is suggested that the program consist of the following:

- **Short Term** – Set up a continuing leak inspection by Maintenance Personnel so that for a while, each primary sector (see drawing) of the plant is inspected once a quarter or at a minimum, once every six months to identify and repair leaks. A record should be kept of these findings and overall results. The PROJECT COST SECTION includes a very effective ultrasonic leak locator quotation for your information.

- **Long Term** -- Consider setting up programs where the production people (particularly the operators and their supervisors) are positively motivated to identify and repair these leaks. One method that has worked well with other operations is to monitor the airflow to each responsible section (perhaps with the use of recording the non-recording flow meters) and to identify the air usage as a measurable part of the operating expense of that area. This usually works best when combined with an effective “In-House” Training And Awareness Program.

Following is the list of leaks that we found while performing a partial leak survey in your plant. We found these leaks in approximately 1 to 2 hours with an ultrasonic leak locator.

Table 7. Partial Leak Survey

No.	Location	Description	Est. Size	Est. Amount	Comments
1	Compressor area IR dryer	Inlet valve seal	Small	1	
2	Compressor area IR dryer	Trap drain	Small	1	
3	Grinding out	Air tool seal	Small	1	
4	Rear assembly area	Hose connector by wall	Small	1	
5	Rear assembly area	Regulator, by thermostat	Small	2	
6	Silk screen	Regulator on wall	Small	1	
7	Front of paint	Valve stem	Small	1	
8	Plating	Pipe junction	Small	2	By ceiling
9	Punch press	Lube drain	Small	1	
10	Raw material storage	Valve	Small	1	
11	Trumatic	QDC fitting	Small	1	
12	Press 020	"T" connection	Small	1	
13	Press 020	Pipe union	Small	1	
14	Press 042	Hole in hose	Small	1	
15	Minster	Regulator	Small	1	
16	Minster	"T" connection	Small	1	
17	Drill press	QDC fitting	Small	1	
	EST TOTAL			**19**	

Savings associated with implementing a leak management program include:

Estimated number of leaks	35 leaks
Estimated average leak size	1 cfm per leak
Calculated leak level	35 cfm
Value of recoverable energy savings (Section 2.4)	$185 per cfm
Total estimated electric savings (@ $185.17 cfm/yr)	$6,500 per cfm/yr

Costs associated with implementing a leak management program include:

Leak detection equipment	$2,800
Leak repair (35 leaks @ $25 materials per leak and $25 labor per leak)	$1,800
Total program cost	$4,600 plus $1,000 annually for ongoing repairs

4.5 AUTOMATIC BALL VALVES

Some of the most significant areas for leaks in any high-production plant involve shutting off the air supply to machinery when not in use. When these are found, there are usually some very economical and easy methods to automatically do this. The PROJECT COST SECTION lists some electric-operated automatic ball valves that can be installed in the main feed line to a piece of equipment and be wired in so as to open and close when the machine is powered up or shut off.

☑ **PHASE II INVESTIGATION (#20)** – Install automatic ball valve for equipment shut offs.

4.6 VACUUM GENERATORS

The plant's current production system does use vacuum generators. Vacuum generators are very convenient, very responsive, and very inefficient compared to positive displacement pumps, i.e., rotary screw, reciprocating.

Energy cost escalates as vacuum goes down with Venturi generators. Energy cost falls as vacuum goes down after about 14" with positive displacement pump. It is very important to only run a Venturi vacuum generator to a minimum vacuum and a minimum acceptable "on time" cycle at the lowest possible pressure.

Your current Venturi vacuum generators should be investigated to see if they are using the lowest effective pressure and are equipped with automatic controls to shut off when not in use.

4.7 AIR-OPERATED DIAPHRAGM PUMPS

Although air-operated diaphragm pumps are not very energy efficient, they tolerate aggressive conditions relatively well and run without catastrophic damage even if the pump is dry. There are several areas to pursue in the future to perhaps generate significant air savings:

- Is the air-operated diaphragm pump the right answer? An electric pump is significantly more power efficient. Electric motor driven diaphragm pumps are available. An electric motor drive progressive cavity pump may well work.

- Consider the installation of electronic or ultrasonic controls to shut the pumps off automatically when they are not needed. Remember the pump uses the most air when it is pumping nothing

- Is the plant running most of the time at the lowest possible pressure? The higher the pressure, the most air used. For example, often in a filter pack operation, the pump does not need high pressure except during the final stages of the filter packing cycle. Controls can be arranged to accomplish lower pressure in the early stages and higher pressure later that can generate significant savings.

☑ **PHASE II INVESTIGATION (#25)** – Review opportunities for improved pump efficiency.

4.8 HEAT RECOVERY

Installation of an air-cooled, lubricant-cooled rotary compressor will allow potential recovery of 85-90% of the motor horsepower in the form of heated air. Heat of compression can also be used to heat process water when that opportunity is available. If this heated air (or water) can be used to offset another source of energy used to heat (i.e., space heaters, etc. in the winter), the savings must be calculated on the basis of the alternate energy cost.

Heat of compression can be used to drive off water from the oil/water condensate and can also be used to supply the drying tower heat in a regenerative desiccant dryer.

☑ **PHASE II INVESTIGATION (#28)** – Review potential for heat recovery.

C

COST-EFFECTIVENESS CALCULATIONS SPREADSHEET

Directions

This sheet is designed to assist prospective energy efficiency providers with a format in which to calculate the cost-effectiveness of their proposed or existing energy efficiency programs.

CELLS

• Each row is designed for the information of one program measure.

• The information required in the blue cells should be entered by the program proposer based on their own information regarding their program and the measures involved. These entries include energy savings and incremental measure costs associated with proposed measures, as well as administrator costs. The energy savings and measure costs associated with certain energy efficient measures can be found in the 2001 DEER Update Study, available at www.calmac.org. For easier program proposal evaluation, the source of all assumptions made, concerning energy savings and incremental measure costs associated with proposed measures, should be documented and submitted with the cost-effectiveness analysis.

• The information required in the red cells should be entered by the program proposer based on the information provided in the Energy Efficiency Policy Manual that accompanied the Decision regarding 2002 energy efficiency programs (R-01-08-028/D-01-11-066). This information includes Effective Useful Lives and Net-to-Gross Ratios as provided in the Energy Efficiency Policy Manual. If an appropriate net-to-gross ratio for a specific program is not provided in the Energy Efficiency Policy Manual, please use the default value of 0.8.

• The program proposer should not modify the information in the black cells. This information is meant for read-only.

SHEETS

• 'Benefits' Sheet: Provides the energy benefits calculations for the proposed energy efficiency program.

• 'Non-Administrator Costs' Sheet: Records the costs incurred by the program participant, associated with the proposed energy efficiency program.

• 'Administrator Costs' Sheet: Records the costs incurred by the program administrator, associated with the proposed energy efficiency program.

• 'Tests' Sheet: Once the 'Benefits', 'Administrator Costs', and 'Non-Administrator Costs' sheets have been completely filled out the tests sheet will provide the cost-effectiveness benefits and ratios for the TRC and Participant tests for the total proposed program.

Program Benefits

Measure Description	No. of Units	Annual Therm Savings per Unit	Annual kWh Savings per Unit	Effective Useful Life (EUL)	Net-to-Gross Ratio	Total Annual gross kWh Savnigs	Total Annual gross Therm Savings	Total Annual net kWh Savings	Total Annual net Therm Savings	Life Cycle net kWh	Life Cycle net Therms	Gross Electricity Benefits	Gross Gas Benefits	Net Electricity Benefits	Net Gas Benefits	Total Gross Benefits	Total Net Benefits
Comp Air Retrofit	40	0	500000	8	0.8	20000000	0	16000000	0	1.28E+08	0	$9,167,310	$0	$7,333,848	$0	$9,167,310	$7,333,848
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
						0	0	0	0	0	0	$0	$0	$0	$0	$0	$0
Program Total								16000000								$9,167,309.57	$7,333,847.65

	Gross Electricity Benefits	Gross Gas Benefits	Net Electricity Benefits	Net Gas Benefits
Load Increases	$0	$0	$0	$0

Non-Administrator Costs

Measure Description	No. of Units	Total Rebate/Financial Incentive per Unit	Total Rebates	Gross Incremental Measure Cost per Unit	Net-to-Gross Ratio	Total Gross Incremental Measure Costs	Total Net Incremental Measure Costs	Total Non-Administrator Costs
Comp Air Retrofit	40	$20,000	$800,000	$50,000	0.80	$2,000,000	$1,600,000	$2,400,000
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
0	0	$0	$0	$0	0.00	$0	$0	$0
Program Total			$800,000			$2,000,000		$2,400,000

Administrator Costs

Administration	$0.00
Labor Costs	$60,000.00
Benefits	$0.00
Overhead Costs	$0.00
Travel Costs	$10,000.00
Reporting Costs	$5,000.00
Material & Handeling Costs	$5,000.00
General & Administrative Costs	$0.00
Subcontractor Costs	$0.00
IOU Administrative Fee (only for non-IOU programs)	*See note Sec. 4
Marketing and Outreach Costs	$584,000.00
Measurement and Evaluation Costs	$60,000.00
Other Costs	
Total Administrator Costs	$724,000.00

Cost Effectiveness Tests

TRC Test	Costs	Benefits	Ratio	Net Benefits
	$2,324,000	$7,333,848	3.155700367	$5,009,848

Participant Test	Costs	Benefits	Ratio	Net Benefits
	$2,000,000	$9,967,310	4.983654783	$7,967,310

Discount Rate

8.15%

AVOIDED COST VALUES

	Electric					Natural Gas				
	Statewide Avg.	Gen	T&D	Env.Ext.	Total		Gen	T&D	Env.Ext.	Total
	Year	$/kWh	$/kWh	$/kWh	$/kWh	Year	$/thm	$/thm	$/thm	$/thm
	2002	0.09905	0.00525	0.00655	$0.11	2002	$0.49	$0.03	$0.06	$0.58
	2003	0.05671	0.0055	0.0068	$0.07	2003	$0.37	$0.03	$0.06	$0.46
	2004	0.05341	0.00574	0.00704	$0.07	2004	$0.34	$0.03	$0.06	$0.43
	2005	0.05451	0.006	0.0072	$0.07	2005	$0.35	$0.03	$0.06	$0.44
	2006	0.04961	0.0062	0.0074	$0.06	2006	$0.37	$0.03	$0.07	$0.47
	2007	0.05155	0.0065	0.0076	$0.07	2007	$0.39	$0.03	$0.07	$0.49
	2008	0.05325	0.00675	0.00785	$0.07	2008	$0.40	$0.04	$0.07	$0.51
	2009	0.0551	0.00704	0.00814	$0.07	2009	$0.42	$0.04	$0.07	$0.53
	2010	0.05708	0.00734	0.00834	$0.07	2010	$0.44	$0.04	$0.07	$0.55
	2011	0.05896	0.0076	0.0086	$0.08	2011	$0.38	$0.04	$0.08	$0.50
	2012	0.06138	0.00794	0.00884	$0.08	2012	$0.40	$0.04	$0.08	$0.52
	2013	0.06399	0.0083	0.0091	$0.08	2013	$0.42	$0.04	$0.08	$0.54
	2014	0.06676	0.0086	0.0094	$0.08	2014	$0.43	$0.04	$0.08	$0.55
	2015	0.06976	0.009	0.0097	$0.09	2015	$0.45	$0.04	$0.09	$0.58
	2016	0.073	0.00934	0.00994	$0.09	2016	$0.48	$0.04	$0.09	$0.61
	2017	0.07649	0.00974	0.01024	$0.10	2017	$0.50	$0.04	$0.09	$0.63
	2018	0.08023	0.01014	0.01054	$0.10	2018	$0.52	$0.05	$0.09	$0.66
	2019	0.08428	0.01055	0.01081	$0.11	2019	$0.54	$0.05	$0.10	$0.69
	2020	0.08844	0.01059	0.01108	$0.11	2020	$0.57	$0.05	$0.10	$0.72
	2021	0.09287	0.01112	0.01136	$0.12	2021	$0.59	$0.05	$0.10	$0.74
	SUM	$1.35	$0.16	$0.18	$1.68	SUM	$8.85	$0.66	$1.57	$11.20
0					$0.00					$0.00
1	PV (1 yr)	$0.10	$0.01	$0.01	$0.11	PV (1 yr)	$0.49	$0.03	$0.06	$0.58
2	PV (2 yr)	$0.15	$0.01	$0.01	$0.17	PV (2 yr)	$0.83	$0.06	$0.12	$1.01
3	PV (3 yr)	$0.20	$0.02	$0.02	$0.23	PV (3 yr)	$1.12	$0.08	$0.17	$1.37
4	PV (4 yr)	$0.24	$0.02	$0.02	$0.28	PV (4 yr)	$1.40	$0.11	$0.21	$1.72
5	PV (5 yr)	$0.28	$0.02	$0.03	$0.33	PV (5 yr)	$1.67	$0.13	$0.27	$2.06
6	PV (6 yr)	$0.31	$0.03	$0.04	$0.38	PV (6 yr)	$1.93	$0.15	$0.31	$2.40
7	PV (7 yr)	$0.34	$0.03	$0.04	$0.42	PV (7 yr)	$2.18	$0.17	$0.36	$2.71
8	PV (8 yr)	$0.38	$0.04	$0.04	$0.46	PV (8 yr)	$2.43	$0.20	$0.40	$3.02
9	PV (9 yr)	$0.41	$0.04	$0.05	$0.50	PV (9 yr)	$2.66	$0.22	$0.43	$3.31
10	PV (10 yr)	$0.44	$0.04	$0.05	$0.53	PV (10 yr)	$2.85	$0.24	$0.47	$3.56
11	PV (11 yr)	$0.46	$0.05	$0.06	$0.57	PV (11 yr)	$3.03	$0.26	$0.51	$3.80
12	PV (12 yr)	$0.49	$0.05	$0.06	$0.60	PV (12 yr)	$3.21	$0.27	$0.54	$4.03
13	PV (13 yr)	$0.52	$0.06	$0.06	$0.64	PV (13 yr)	$3.38	$0.29	$0.58	$4.24
14	PV (14 yr)	$0.54	$0.06	$0.07	$0.67	PV (14 yr)	$3.54	$0.30	$0.61	$4.45
15	PV (15 yr)	$0.57	$0.06	$0.07	$0.70	PV (15 yr)	$3.70	$0.32	$0.64	$4.65
16	PV (16 yr)	$0.59	$0.06	$0.07	$0.73	PV (16 yr)	$3.85	$0.33	$0.67	$4.85
17	PV (17 yr)	$0.61	$0.07	$0.08	$0.76	PV (17 yr)	$4.00	$0.34	$0.69	$5.04
18	PV (18 yr)	$0.64	$0.07	$0.08	$0.79	PV (18 yr)	$4.15	$0.36	$0.72	$5.22
19	PV (19 yr)	$0.66	$0.07	$0.08	$0.81	PV (19 yr)	$4.28	$0.37	$0.74	$5.40
20	PV (20 yr)	$0.68	$0.08	$0.09	$0.84	PV (20 yr)	$4.42	$0.38	$0.76	$5.56

D

QUALIFICATIONS

D.1 XENERGY QUALIFICATIONS

With over 20 years of experience, XENERGY has conducted energy efficiency and energy cost reduction audits for more than 100,000 clients.

Since 1975, XENERGY has been a recognized leader in providing industrial, commercial, and institutional building owners, government agencies, and utilities with a complete and integrated set of energy services designed to improve energy efficiency and reduce energy costs.

XENERGY's 200 employees throughout the United States and Canada are experts in energy engineering, energy audits, construction management, design/build services, performance contracting, energy regulatory testimony, energy metering and statistical analysis, and energy software development.

XENERGY provides energy engineering and construction implementation work for industrial customers and more than 100 electric and gas utilities and dozens of state and federal government agencies, including the United States Army, the United States Air Force, the Department of Defense, the Department of Energy, the Internal Revenue Service, the Environmental Protection Agency, the Department of Health and Human Services, the Department of the Navy, the General Services Administration, and the United States Postal Service.

D.1.2 Commercial & Industrial Projects

Owens-Brockway Glass Containers, *Toledo, Ohio*

XENERGY provided technical consulting services to Owens-Brockway to evaluate cost savings opportunities at 26 of its domestic glass container plants. Services included identifying, justifying, developing, designing and installing energy efficiency and electrical cost savings opportunities. In addition, XENERGY advised Owens-Brockway on utility-related issues such as deregulation, power quality, and on-site generation.

Owens-Brockway Glass Containers, *Oakland, California*

XENERGY identified an opportunity at the Owens-Brockway glass container manufacturing plant in Oakland California to reduce annual electric costs by one million dollars per year by upgrading to transmission level voltage. XENERGY negotiated the upgrade with the utility and provided turnkey design and installation of a 115 MW substation on site.

Contact: Mr. Hank Weigel
Telephone No.: 510-436-2058
Year Completed: 1997

Owens-Brockway Glass Containers, *Portland, Oregon*

Under contract to PacifiCorp, through its Energy FinAnswer program, XENERGY evaluated the plant compressed air system for energy efficiency savings opportunities. XENERGY identified measures that would reduce annual electrical consumption by 1,914,723 kWh/yr and overall demand by 219.4 kW. Annual cost savings were expected to be $70,000/yr. Conservation measures included reductions in end use requirements and an interactive automated control system for nine compressors.

Contact: Mr. Bob Dolphin
Telephone No.: 503-251-9415
Year Completed: 1997

Owens-Brockway, *Lakeland, Florida*

XENERGY was called upon to help solve serious weather related service interruption problems at the Lakeland, Florida Glass Container Plant. Lightning and storm related outages had historically caused more than 20 plant wide shutdowns per year. XENERGY negotiated the installation of a transmission level substation with Lakeland Electric and Water. Following installation of the substation, the plant experienced no further storm related shutdowns.

Contact: Mr. Robert Morely

Telephone No.: 941-680-4828

Year Completed: 1998

Carlsbad Research Center, *Carlsbad, California*

For these two buildings, totaling 88,000 square feet, XENERGY was able to identify cost effective, aesthetically pleasing measures to reduce excessive solar gain. Both buildings had grossly undersized central plants supplying a system of water source heat pumps. Based on building simulation modeling, we also recommended doubling the size of the buildings' cooling towers, to allow lower approach temperatures so that circulation rates could be reduced below acoustical threshold levels in the undersized cooling loop piping. Replacement cooling towers were specified that could provide the needed heat rejection and still fit in the existing mechanical equipment enclosure which had been built into a landscaped hillside in the outdoor parking lot. By not modifying duct work and piping inside the building, the customer was able to avoid costly Title 24 requirements for outside air volumes, which would have also resulted in significantly higher cooling energy use.

Contact: Mr. Raoul Gazi

Telephone No.: 619-792-0581

Year Completed: 1998

Sony Pictures, *Culver City, California*

XENERGY was contracted to provide strategic negotiating support for Sony's Culver City studio to obtain transmission-level electric service and consolidate multiple services into a single service, which will allow Sony to receive a 30 percent reduction in its electricity costs. XENERGY also provided continuous on-site project management of the Client's underground substructure installation and direct supervision over all contractors. XENERGY had budgetary responsibility for the substructure construction work and was also asked to be responsible for the telecommunications (fiber optics) work.

Buffalo Paperboard Corporation, *Lockport, New York*

XENERGY provided engineering, design services, material procurement, project coordination, and construction for a 1,500 kva, three-phase, 34.5 to 2.4 kv addition to its existing substation to operate a new 800 HP refiner motor.

World Trade Center, *Boston, Massachusetts*

XENERGY, through its wholly-owned subsidiary, KEM, Inc., provided engineering, design, construction management and construction services for a complete redesign of World Trade Center's HVAC heat pumping systems. In addition, new and retrofit T8 electronic ballasts and lamps, compact fluorescents, and exit sign retrofits were installed. The project was delivered at no cost to the customer (Commonwealth Pier Trust II and FMR Corporation) because it was incorporated into Boston Edison Company's "Encore" DSM program. The project reduced electrical demand by more than 500 kW and energy consumption by more than 2 million kWh per year.

Boston Design Center, *Boston, Massachusetts*

XENERGY, through its wholly owned subsidiary, KEM, Inc., provided engineering, design, construction management and construction services for new HVAC control and VFD systems. In addition, new and retrofit T8 electronic ballast and lamps, compact fluorescents, and exit sign retrofits were used. The project was delivered at no cost to the customer because it was incorporated into Boston Edison Company's "Encore" DSM program. The project reduced electrical demand by more than 80 kW and energy consumption by more than 400,000 kWh per year.

XENERGY Inc., *Burlington, Massachusetts*

XENERGY designed and installed a state-of-the-art lighting DSM project in its own 40,000-square-foot corporate headquarters. The result: an award-winning showcase of lighting systems, including the latest generation of lamps and ballasts, daylight dimming systems, manual fluorescent dimming, occupancy sensors, reflectors, and a variety of new luminaires.

The unit lighting power allowance is less than 0.9 watts/sq. ft. (the state building code and ASHRAE 90.1 permit up to 1.6 watts/sq. ft.); with the power adjustment factor for occupancy controls and daylight dimmers in our space controls, the power allowance is 0.63 watts/sq. ft. Retrofitting its own facility allowed XENERGY engineers the opportunity to experiment with the efficiency of different lighting products and their applications. XENERGY, through the Boston Edison Custom Lighting Rebate Program, received a substantial rebate incentive.

Rutgers University, *Newark, New Jersey*

XENERGY, through its wholly-owned subsidiary, KEM, Inc., provided engineering, design, construction management, and construction services for new and retrofit energy-efficient lighting across the Rutgers campus. New and retrofit T8 electronic ballasts and lamps, compact fluorescents, and exit sign retrofits were used. The project also captured Public Service Electric and Gas (PSE&G) DSM rebates of approximately $1 million. The project reduced electricity demand by more than 1 MW and energy consumption by more than 4 million kWh per year. XENERGY is providing ongoing monitoring and energy savings verification services.

Northeastern University, *Boston, Massachusetts*

XENERGY provided engineering, design, construction management, and construction services for installation of energy-efficient lighting systems, energy management systems, HVAC systems, and high-efficiency motors across campus. Annual electricity savings exceed 11 million kWh. For maximum access to utility rebates, the project was incorporated into a Boston Edison Company DSM program. The university will collect rebates over a 10-year period. XENERGY will provide ongoing monitoring and energy savings verification services.

Shamrock and Clark Schools, *Woburn and Lexington, Massachusetts*

As part of the Boston Edison Energy Efficiency Partnership, XENERGY completed a $1.4 million design/build project to retrofit the existing resistance electric heating units in the two schools with heat pumps. The project was completed on a tight timetable and below budget.

Binghamton Schools, *Binghamton, New York*

For a New York State Electric and Gas DSM program, XENERGY designed and installed a $300,000 lighting retrofit program for 14 buildings in the Binghamton school system. Improvements included lamps, ballasts, new luminaires, and lighting controls.

Donna Independent School District, *Donna, Texas*

XENERGY installed a thermal storage system to provide off-peak ice generation, supplemented and refurbished the existing chiller systems, and installed energy-efficient lighting throughout the school system. XENERGY arranged for municipal lease financing and helped apply for a utility rebate, which reduced the capitalized cost of the project. XENERGY guaranteed the project's energy performance; the projected savings of $140,000 were exceeded by more than 15 percent. The project resulted in chiller peak-demand savings of 400 kW and annual electricity savings of 950,000 kWh. The total project value was $1.3 million.

Regal Constellation Hotel, *Toronto, Ontario*

XENERGY, through its wholly-owned subsidiary, KEM, Ltd., provided engineering, design, construction management, and installation services for a new energy management system. In addition, XENERGY retrofitted lighting in the Convention Center and Hotel to T8 electronic ballasts and lamps, compact fluorescents, motion detectors, and LED exit signs. The project was incorporated into Ontario Hydro's DSM program for maximum access to utility rebates. The project reduces the hotel's annual energy consumption by more than 1.8 million kWh. KEM is providing metering and monitoring services and a three-year guarantee for energy cost reduction.

North Adams Regional Hospital, *North Adams, Massachusetts*

XENERGY conducted a detailed engineering study and provided design engineering, bid management, and construction supervision services for energy retrofits of a cogeneration system, a boiler replacement, an energy management system, and a lighting system design. The cogeneration system was designed entirely by XENERGY and involved a packaged unit with power generation capacity of 400 kW tied into a redesigned boiler plant.

Lahey Clinic, *Burlington, Massachusetts*

For the Lahey Clinic, a 300,000-square-foot hospital near Boston, XENERGY completed an energy study and later designed and managed a $1 million project to replace the chillers in the hospital.

Westland Medical Center, *Westland, Michigan*

XENERGY evaluated and provided turn-key design engineering for the replacement of a 600-ton absorption chiller with an electric chiller. The design elements included electric system upgrade, mechanical and electrical connections, and structural and civil engineering.

Mt. Carmel Mercy Hospital, *Detroit, Michigan*

XENERGY engineers supervised the design of a 1.6 MW cogeneration system installed at the hospital. XENERGY also provided technical construction management and administrative services.

VA Hospital, *Bedford, Massachusetts*

XENERGY evaluated the HVAC systems and controls at this hospital. Services included a detailed investigation of the operation and maintenance of the mechanical equipment, followed by the construction administration of a facility-wide, $350,000 control-system upgrade.

Oneida City Hospital, *Oneida, New York*

XENERGY provided engineering, design, construction management, and construction services for new and retrofit energy-efficient lighting and motor replacement for a 148-bed, 150,000-square-foot hospital. New and retrofit T8 electronic ballasts and lamps, compact fluorescents, and exit sign retrofits were used.

Hackensack Medical Center, *Hackensack, New Jersey*

XENERGY, through its wholly-owned subsidiary, KEM, Inc., provided engineering, design, construction management, and construction services for new and retrofit energy-efficient lighting for this primary care hospital. The project reduced electricity demand by more than 300 kW and energy consumption by over 1.9 million kWh per year. New and retrofit T8 electronic ballasts and lamps, compact fluorescents, and exit sign retrofits were used. The project also captured approximately $500,000 in Public Service Electric and Gas (PSE&G) DSM rebates.

The Printed Circuit Corporation, *Waltham, Massachusetts.*

This 100,000 square foot, two-story, mixed-use facility includes office space, clean rooms, warehousing, and light assembly. Comfort cooling in the facility was provided by six packaged rooftop units; clean rooms were cooled by two air-cooled reciprocating chillers. Facility lighting was provided by a combination of incandescent, T12 fluorescents with magnetic core-coil ballasts, and high-pressure sodium and mercury-vapor luminaires. Essentially all HVAC and process motors at Printed Circuit were of standard efficiency designs.

XENERGY recommended high-efficiency lighting (T8 lamps with electronic ballasts, compact fluorescents, and high-pressure sodium luminaires), energy-efficient motors, and chiller and rooftop unit upgrades. These upgrades save approximately $73,850 annually, providing an internal rate of return of 109 percent. All recommended upgrades have been installed and a monitoring program verifies that actual savings are within 8 percent of engineering estimates.

Pratt & Whitney (Division of United Technologies), *East Hartford, Connecticut*

XENERGY studied a wide variety of building-related systems, including lighting, HVAC, variable speed pumping, cooling tower variable speed fans, energy management and control systems, and chiller system retrofits (hot gas bypass and reclaim). The study encompassed four buildings totaling 1.3 million square feet. XENERGY then provided engineering, design, construction management, and construction services for energy-efficient lighting of Building L, a 550,000 square foot facility for machinery and assembly of jet engine components. The space included office space, a cafeteria, and a shipping and receiving area. New metal-halide high bay glass luminaires, T8 electronic ballasts and lamps, new high-pressure sodium high bay glass luminaires, low bay metal-halide luminaires, and new and retrofit compact fluorescent luminaires were used. Total project costs were $770,000, for which Northeast Utilities offered a $280,000 incentive.

Hamilton Standard (Division of United Technologies), *Windsor Locks, Connecticut*

A comprehensive study by XENERGY of this 1.8 million-square-foot manufacturing facility covered lighting, motors, HVAC, office and factory equipment power, energy management and control systems, central metering, compressed air control exhaust system, variable speed fans and pumps, cooling tower modification, and extensive chilled water system modifications.

Corning Inc. - Pressware Division, *Corning, New York*

XENERGY conducted a comprehensive evaluation of this electric glass-melting operation and identified major efficiency improvements for high-efficiency lighting, variable speed drives on large cooling fan motors, automatic controls on air compressors and pressware cooling systems, high-efficiency belt drives and gearbox lubricants, and high-efficiency motors.

James River Paper Mill, *Virginia*

XENERGY provided a detailed engineering study to assess energy conservation and cogeneration potential. The energy conservation measures included dryer heat recovery, plant efficiency improvements, and lighting system redesign. The cogeneration feasibility involved a 1 MW gas turbine and a 70 kW steam turbine.

Combustion Engineering (Division of United Technologies), *Windsor, Connecticut*

XENERGY conducted a detailed audit of this 880,000 square foot, 20-building campus of offices, laboratories, and manufacturing facilities. Significant savings were identified in the lighting systems, HVAC systems, central chiller and pumping plants, and overall centralized energy management and control systems.

Varian Ion Implants, Gloucester, *Massachusetts*

In a comprehensive engineering analysis on a manufacturing building plagued by inconsistent ventilation and temperature control, XENERGY provided a complete design/build fixed price to Varian for a new makeup air unit, DDC controls, and complete system rebalancing. XENERGY prepurchased and installed new equipment and had it operating two weeks ahead of schedule. All ventilation and temperature problems were eliminated.

Digital Equipment Corporation, *Maynard, Massachusetts, and Merrimack, New Hampshire*

XENERGY conducted an energy study and provided design engineering, bid management, and construction supervision services for installing energy management systems Digital Equipment Corporation offices. The construction costs for these two projects were approximately $900,000. The Maynard system, which provides energy management and facilities operation control, serves the large world headquarters facility (approximately 1.8 million square feet). XENERGY specifications are now used as the standard for Digital plants around the country. The system won an ASHRAE design award in the commercial building category.

World Color Press, Inc.

In an innovative energy supply and service partnership, XENERGY and PanEnergy Corporation were chosen to contain energy costs and enhance operations for one of the largest diversified providers of printing and digital information in North America. XENERGY and PanEnergy will provide a complete range of energy services, including delivering gas and electricity, improving energy efficiencies, and managing the company’s transition through the electric industry’s restructuring at more than 40 World Color Press plant locations.

Sweet Life Foods, *Suffield, Connecticut*

XENERGY analyzed and coordinated the expansion and consolidation of various coolers and freezers for maximum energy efficiency. The 1.5 million-square-foot food distribution warehouse was studied under Northeast Utilities' Energy Conscious Construction rebate program and, based on XENERGY's recommendations, qualified for a rebate of more than $1 million for improvements in the design and efficiency of the proposed central ammonia plant. Improvements included high-efficiency screw compressors; low-energy-use evaporators and evaporative condensers; improved truck dock doors and seals; automatic-operated cooler and dry warehouse doors; improved controls of evaporators, compressors, and condensers; and improved roof and wall insulation. The second phase of the project will be the conversion of existing halocarbon freezer refrigeration units to an expanded central ammonia plant.

H. J. Heinz (Weight Watcher Foods), *Wethersfield, Connecticut*

XENERGY evaluated all aspects of refrigeration, production, lighting, and HVAC for this major producer of frozen dinners, determined optimum energy savings, and helped secure potential rebates of over $900,000. A 30 percent reduction of energy consumption is predicted from the anticipated $1.2 million investment, yielding a one-year overall simple payback. Measures recommended for implementation included variable speed drives, an energy management system, evaporator and piping replacements, process heat exchanger improvements, thermosyphon oil cooling, heat recovery, and high-efficiency motors and lighting. Annual hourly simulations of the performance of refrigeration systems was accomplished using XENERGY's proprietary PSR software.

H. P. Hood (Ice Cream Division), *Suffield, Connecticut*

XENERGY conducted a comprehensive study of this 500,000 square foot ice cream manufacturing plant, recommending modifications to its refrigeration systems, including high-efficiency compressors, conversion of freon units to ammonia, enhancement of an energy management system, re-piping of various ammonia evaporators to improve energy efficiency, and high-efficiency compressor lubricants.

Friendly Ice Cream, *Wilbraham, Massachusetts*

XENERGY implemented a comprehensive redesign of process and storage refrigeration piping and the addition of a new refrigeration plant using high-efficiency screw compressors to handle very low temperature operations (-42°F), saving over 16 percent in refrigeration energy. Additional measures included the installation of two double-walled vented heat exchangers, which use hot refrigerant gas as the heat source to preheat domestic hot water, and the reconfiguration and expansion of the evaporative condensers. Northeast Utilities awarded over $800,000 in rebates to this successful project. XENERGY performed verification and validation of the savings, which were required by the utility, and confirmed that savings were within 8 percent of anticipated amounts.

Natural Country Farms, *Ellington, Connecticut*

XENERGY completed a comprehensive energy evaluation of the freon-based ice storage and refrigeration system used to manufacture juice products. XENERGY individually analyzed more than 15 separate refrigeration units and studied the entire plant for consolidation of loads and improved efficiency. As a result of XENERGY's detailed study, the whole plant was converted to an ammonia-based refrigeration system, with improved water chilling capacity and significantly reduced energy use (25 percent savings on a $215,000 annual electric bill). The $500,000 project was awarded a rebate of over $400,000 by Northeast Utilities based on XENERGY's study.

Emerson Electric, Power Transmission Division, *Ithaca, New York*

As part of a competitively bid DSM program for New York State Electric and Gas, XENERGY completed an energy audit for a 500,000 square foot facility and then served as construction manager for the recommended energy improvements. These included lighting system retrofits, an energy management system to control HVAC systems, and the addition of industrial controls and adjustable speed drives for the production line. The total project value was approximately $200,000.

Pfizer Corporation

XENERGY conducted a detailed engineering study to assess energy savings potential for this chemical manufacturer. The study established total savings of more than $800,000 with an investment of $4.75 million. The recommendations included power factor correction, a 5.0 MW cogeneration unit, preheat cogeneration, and cheaper fuel supply contracts.

Ford Motor Company, *Edison, New Jersey*

XENERGY, through its wholly-owned subsidiary, KEM, Inc., incorporated complex control and energy systems upgrades into Ford’s car body painting system. The project, with a total value of $5 million, has led to energy savings of approximately $2 million. The project also included installation of plant-wide energy-efficient lighting systems. Annual energy savings total more than 13.5 million kWh. XENERGY is providing ongoing monitoring and energy savings verification services.

Ford Motor Company of Canada, *St. Thomas, Ontario*

XENERGY, through its wholly-owned subsidiary KEM, Ltd., provided engineering, design, construction management, and installation services to deliver new Computerized Distributed Controls for the five plant air compressors and cooling water system at this integrated car assembly facility. The project was incorporated into Ontario Hydro's DSM program for maximum access to utility rebates. The project provided a new technology upgrade and reduces the annual energy consumption by over 1.15 million kWh. KEM is providing metering and monitoring services and a one-year energy savings guarantee program for this project.

CHT Steel Company Inc., *Richmond Hill, Ontario*

XENERGY, through its wholly-owned subsidiary, KEM, Ltd., provided engineering, design, construction management, and installation services for a complete retrofit of the lighting at this steel heat treating facility, which is a division of STELCO Canada. New high-output metal-halide lamps, complete with reflectors and remote-mounted energy-efficient magnetic ballasts, were used. The project reduces annual energy consumption at the facility by more than 570,000 kWh. KEM is providing monitoring services to assure the owner of achieving the projected energy savings.

D.1.3 Energy Engineering for California Cities and Municipalities

Alameda County Waste Management Authority (ACWMA) Green Building Design Assistance Program, San Leandro, California.

XENERGY provides on-going commercial green building consulting services to the Alameda County Waste Management Authority (ACWMA). Through XENERGY, ACWMA provides design assistance to projects in early stages in the 16 cities of Alameda County covering issues such as energy efficiency, siting for transit access, controlling erosion, materials selection for durability and health, waste recycling and indoor air quality. XENERGY has drafted sample city ordinances requiring compliance with the LEED Rating System. These sample ordinances are currently being considered by staff and council in the City of Dublin and are being prepared for distribution via ACWMA's website. XENERGY also provides frequent training to city staff, architects, engineers, planners, developers and concerned citizens in design assistance. Training sessions have covered everything from advanced construction techniques for energy efficient building shells to specifications of non-toxic paints and adhesives. The current training session is on strategies for achieving maximum impact with minimum cost by getting involved very early in a project design so that significant changes can be made inexpensively. Changing a building's orientation for solar access is a good example of a low cost method for reducing solar gain, but after significant design work has been completed, the cost of this change goes up. Many of the projects XENERGY works on make use of both the design assistance and the training programs.

One project that has used XENERGY for both design assistance and green building training is Alameda County's proposed East County Courthouse and Juvenile Detention Center in Dublin. XENERGY has reviewed schematic plans for the 950,000 square foot project and made recommendations for, building energy efficiency, photovoltaic power generation, water retention, minimizing paved areas to reduce the heat island effect, and the other LEED-related topic areas. Recommendations have included the use of a raised floor air distribution system in the offices and courts and extensive daylighting to minimize energy use, and water efficient appliances, drought-tolerant landscaping and grading for retention ponds. Perhaps more importantly, XENERGY has provided customized training to each member of the design team in the green building areas that relate to their specialty. For example, the mechanical engineer was unfamiliar with raised floor air distribution systems, so XENERGY provided case studies, design guides and a tour of an existing facility to demonstrate the technology.

Contact: Ms. Ann Ludwig
Telephone No.: 510-614-1699
Year Completed: Ongoing

Roseville Electric Company, Roseville, California

XENERGY is providing technical assistance for industrial and commercial customers of Roseville Electric Company, a California municipal utility. These audits include an evaluation of all electrical systems, including lighting, HVAC, motors, and process end uses. To date, XENERGY has performed audits of 30 sites, including City buildings, the Municipal Wastewater Treatment Plant, a semi-conductor fabrication facility, a hospital, office buildings, a solid waste treatment facility, a college campus, and a telephone company. In addition, XENERGY was selected to help implement the Summer Peak Load Reduction Program for the City. XENERGY helped to recruit customers to participate in the voluntary load shedding program, identified and quantified curtailable loads, advised the customers and Roseville Electric on technologies necessary to automate the curtailment, and verified the installation and effectiveness of the measures. XENERGY also assisted in developing baseline load profiles for each of 29 participating customers to be used in determining payments by the state program to Roseville Electric and its customers.

Contact: Mr. Martin Bailey
Telephone No.: 916-774-5617
Year Completed: Ongoing

City of Santa Ana, Santa Ana, California

XENERGY was hired by the City of Santa Ana to develop a Strategic Electric Plan for energy cost control in the City. As part of this contract, XENERGY studied all 795 city electric accounts, conducted a right/best analysis for each account, and did energy audits of city libraries, police and fire stations, city parks, outdoor stadiums, parking structures, senior centers, and the City Hall. XENERGY also conducted an in-depth analysis of energy uses for city street lighting, traffic control, and the city's municipal water department. Taken together, XENERGY's recommendations for energy conservation measures; improvements to the way in which City accounts were structured, billed, and paid; and procurement strategies are expected to save the City over $1 million annually.

Contact: Ms. Teri Cable
Telephone No.: 714-647-5658
Year Completed: 1998

City of Mountain View, Mountain View, California

XENERGY performed energy audits of four city buildings including the Police and Fire Administration Building, a Senior Center, a Community Center and a Fire Station. As a result of its analysis, XENERGY recommended lighting and HVAC improvements which would reduce the city's use of electricity by over $45,000 per year.

Contact: Mr. Buzz Glazky
Telephone No.: 650-903-6255
Year Completed: 1997

City of Seaside, Seaside, California

XENERGY performed energy audits of four city buildings including the City Hall/Police Station and its parking lot, Oldemeyer Community Center, the Pattullo Swim Center, and the Fire Station. As a result of its analysis, XENERGY recommended new high efficiency motors for AC air handling equipment and pool pumps, interior and exterior lighting upgrades and HVAC improvements, and other measures—which, when taken together, are expected to reduce the City's use of electricity by almost $21,000 per year.

Contact: Ms Diana Ingersoll
Telephone No.: (831) 899-6230
Year Completed: 1994

Shasta County Detention Center, *Redding, California*

XENERGY performed an energy audit of the Shasta County Jail and Court facility and its parking garage in Redding, California. XENERGY identified over $107,000 in annual savings, which reduced this facility's cost for gas and electricity by over 33 percent. Savings measures included improvements to building HVAC controls, conversion from electricity to gas, domestic hot water heating, lighting upgrades, conversion from electricity to gas laundry dryers, and variable speed fan drives.

Under a contract for the California Energy Commission, XENERGY audited the County of Shasta Detention and Courts Facility and its parking garage in Redding, California. XENERGY identified over $107,000 in annual savings, which reduced this facility's cost for gas and electricity by over 33 percent. Savings measures included installation of a high efficiency pulse type boiler for kitchen and laundry hot water needs and outside temperature lockout controls for existing space conditioning boilers and reset controls for cooling equipment when boilers are off line, conversion from electricity to gas, domestic hot water heating, lighting upgrades, conversion from electricity to gas laundry dryers, and variable speed fan drives for AC supply and return fans. In addition, XENERGY recommended several control improvements to optimize the use of economizers on space cooling equipment replacement of existing chillers with new high efficiency equipment.

Contact: Brad Meister
Telephone No.: 916-653-1594
Year Completed: 1994

D.1.4 Audit-Evaluation-Installation and Program Design

Wastewater Plant Energy Benchmarking Study, Pacific Gas and Electric Company, *California*

XENERGY was selected to study energy use in wastewater treatment plant aeration processes in the service territory of Pacific Gas and Electric Company. In all, eight processes were benchmarked for energy use against daily average throughput and lbs of BOD destroyed. In addition, an oxygen utilization factor was calculated for each process. The benchmarks for these processes were then compared. The processes studied included surface aeration, coarse bubble diffusion, fine bubble diffusion, rotating biological contactors, and pure oxygen technologies. The results of the study will be presented to a roundtable of industry experts in November.

Contact: Mr. Steven Fok

Telephone No.: 415-973-4735

Year Completed: 2001

Partners in Energy Program, Sacramento Municipal Utilities District*, Sacramento, California*

XENERGY contracted with the Sacramento Municipal Utilities District (SMUD) to serve as a Prime for the delivery of their *Partners in Energy Program.* The program offered rebate incentives to commercial and industrial customers for the implementation of energy efficiency measures in their facilities. As Prime, XENERGY has a dedicated staff of field auditors and engineers to conduct site analyses and make recommendations for cost-effective upgrades. The program addressed all electrical end uses, including lighting, motors, HVAC, and refrigeration. At the 740-plus XENERGY project sites, electricity demand was reduced by more than 3.4 MW and energy consumption by over 17 million kWh per year.

XENERGY contracted directly with the commercial/industrial customers to implement the recommended measures, and used a network of electrical contractors and other trade professionals to install state-of-the-art technologies.

Contact: Mr. Mike Weedall

Telephone No.: 916-732-5494

Year Completed: 1996

Model Energy Communities Program, Pacific Gas and Electric Company*, California*

XENERGY contracted with the Pacific Gas and Electric Company (PG&E) to serve as a Prime for the delivery of their *Model Energy Communities Program* to commercial building. The program offered rebate incentives to commercial and industrial customers for the implementation of energy efficiency measures in their facilities. As Prime, XENERGY has a dedicated staff of field auditors and engineers to conduct site analyses and make recommendations for cost-effective upgrades. The program addressed all electrical end uses, including lighting, motors, HVAC, and refrigeration.

Contact: Ms. Valerie Richardson
Telephone No.: 415-973-7000
Year Completed: 1994

***Evaluation of the 1998 Nonresidential Standard Performance Contract Program**, **California Board for Energy Efficiency** San Francisco, California, and **Southern California Edison Company,** Rosemead, California*

XENERGY is currently evaluating the effectiveness of the state's largest energy efficiency standard performance contract (SPC) program for investor-owned utilities. In 1998, this program involved over $40 million of performance contract work involving projects throughout the territories of the state's three largest investor-owned utilities—PG&E, SCE, and SDG&E. As a result of XENERGY's analysis, several major changes were made in the program design features for 1999. Further changes based on XENERGY's recommendations are being considered for the program for the year 2000.

Contact: Pierre Landry
Telephone No.: 626-302-8288
Year Completed: 1999

Residential Audits/Residential and Commercial Lighting Retrofits- Anaheim Public Utility

XENERGY is providing a full-scale, turnkey service for residential water and electric customers who participate in Anaheim Advantage Services energy programs. The on-site audits involve data collection of customers' equipment and usage patterns as well as the installation of several energy efficient measures. Issues concerning energy efficient lighting for inside and outside the home, electrical appliance usage, and air duct efficiency are addressed as well. The first year goal is to address 1,200 homes for the residential audit, 900 participants for the indoor and outdoor lighting programs, and 200 customers for the air duct efficiency program.

Water conservation concerns are addressed both inside and outside the home. Customer education covers water usage regarding laundry, dish washing, and bathing habits, followed by the installation of energy saving water devices such as low flow shower heads and faucet aerators. Installation of toilet dams is preceded by toilet tank leak testing and conversations with the customer regarding newer low-flow toilets. Outside water audits include checking sprinkler heads for proper operation and positioning, utilizing different watering approaches for different landscaping needs, optimizing watering schedules to reduce water usage, and water leak checks at the meter.

XENERGY also provides a commercial lighting retrofit program for businesses in the Anaheim Public Utility domain interested in energy efficient outdoor security lighting fixtures.

The scope of the project includes management and support to the field staff, as well as scheduling and supporting the residential and commercial customers while providing the utility with a full database.

Contact: Mr. Phil Hayes
Telephone No.: 714-765-4267
Year Completed: Ongoing

New York Power Authority*, New York, New York*

XENERGY has served as one of several implementation contractors for the Power Authority's lighting efficiency program. Over the course of four years, XENERGY has completed hundreds of audits of public buildings, ranging from schools to airports. After an audit's findings have been approved, XENERGY acts as implementation contractor, purchasing the lighting materials and hiring contractors for installation.

Contact: Mr. Angelo Esposito

Telephone No.: 212-468-6931

Year Completed: 1996

Energy Efficiency Program Implementation Support Hawaiian Electric Company, *Honolulu, Hawaii*

XENERGY provides consulting and technical support to Hawaiian Electric Company in designing and implementing their non-residential energy efficiency programs. During the last four years, XENERGY has:

- assisted in the design of program applications and marketing materials,
- developed worksheets for assessing measures such as variable speed drives, cooling towers, and energy management systems,
- conducted a process evaluation of the program's practices, and
- developed a set of policy and procedure manuals for the program.

Contact: Norris Creveston

Telephone No.: 808-543-4789

Year Completed: On-going

Residential DSM Program, Montana Power, *Butte Montana*

XENERGY is currently running a residential DSM program for energy efficiency improvements. Residential customers are offered a complete natural gas, electric and/or propane analysis service including an audit, an appliance and furnace safety check, detailed electronic bill analysis (RECAP), installation of low cost energy conservation measures, and a blower door air tightness investigation. In the past eight years, XENERGY has performed more than 35,000 of these detailed audits in Montana and will complete another 3,000 in 1999. XENERGY is using its RECAP energy analysis software to produce customized energy reports, which are sent out to customers following the on-site visit. This program was recently expanded to include commercial customers.

Contact: Deb Young
Telephone No.: 406-723-5421
Year Completed: On-going

D.1.5 Energy Engineering at Government and Institutional Buildings

U.S. Army Energy Efficiency Audit and Retrofit Program*, Baltimore District Corps of Engineers*

XENERGY is performing lighting surveys, electrical motor surveys, steam trap surveys, and lighting and motor retrofits for 90 CONUS bases. XENERGY performs these surveys with a customized version of its proprietary auditing tool, InSite™, to identify those lighting and motor retrofits projects that are cost effective, will reduce energy consumption, and will not significantly reduce lighting levels or motor efficiencies. XENERGY performed all lighting and motor retrofits within 120 days of issuance of the Deliver Order, based upon analyses performed during the survey period. These retrofits included all appropriate motors, fluorescent fixtures, compact fluorescents, and exit lamps. In addition, XENERGY disposes of all removed fluorescent lamps and ballasts in accordance with all applicable federal and local laws and regulations. Ballasts with PCB, or the PCB-contaminated components in such ballasts, are incinerated.

Contact: Mr. Jim Paton
Telephone No.: 703-806-6091
Year Completed: 1997

Hanscom Air Force Base, *Hanscom Air Force Base, Massachusetts*

For the Air Force's Electronic Systems Division, XENERGY performed an energy audit of the 190 buildings. All systems, including the central plant, were studied; recommendations resulted in the base achieving its presidentially mandated goal of a 20 percent energy savings by the year 2010. XENERGY also helped create a base-wide comprehensive energy plan and a feasibility study for the installation of a $3.5 million energy management system.

Contact: Ms. Joan Croteau

Telephone No.: 617-377-4350

Year Completed: 1996

***U.S. Postal Service**, Northeast Region*

Under its contract for energy conservation and design services at major postal facilities in the Northeast Region, XENERGY conducted HVAC modifications and building shell insulation changes at the General Mail Facility in Boston, and the main post offices in Pawtucket, Rhode Island, and Needham, Massachusetts. HVAC modifications included outside air, economizer, and temperature controls with fan duty cycling. Construction costs totaled $2.4 million for these facilities, which encompasses 1.8 million square feet.

Contact: Mr. Ron Grady

Telephone No.: 860-285-8213

Year Completed: 1998

***South Postal Annex, U.S. Postal Service**, Boston, Massachusetts*

XENERGY performed a complete energy audit of the 511,975 square-foot South Postal Annex with 1,500 tons of installed chilled water capacity. The chiller plant optimization package recommended a reset of chilled water temperature to match loads and reduced condenser water temperature with optimized fan operation.

***Environmental Protection Agency,** Washington, D.C.*

As an Energy Star Contractor, XENERGY performed an energy efficiency audit of *Synergy Semiconductors*, a semiconductor fab facility in Santa Clara California. Supplied audit-design support to identify energy saving potential for various facility systems including cleanroom and office HVAC systems, lighting, chillers, boilers, variable speed drives, air compressors and incinerators. Conducted site surveys, developed computer simulations, estimated project costs, presented results, and responded to customer requests for additional information.

Contact: Matt Williamson

Telephone No.: 202-564-9094

Year Completed: 1998

IRS Regional Service Center*, Andover, Massachusetts*

XENERGY performed a detailed design involving the replacement of an existing 440-ton steam absorption chiller with a high-efficiency, 450-ton centrifugal chiller. The design also covered a comprehensive chiller status monitoring panel, electrical distribution, cooling tower, and sump controls.

U.S. Post Office, *Springfield, Massachusetts*

Under its contract for energy conservation and design services, XENERGY conducted HVAC modifications and building shell insulation changes at the General Mail Facility and Bulk Mail Facility. Among the HVAC modifications were outside air, economizer, and temperature controls with fan duty cycling; a complete energy management system; replacement of three old chillers with new HCF-123 centrifugal chillers; heat recovery from reciprocating compressors; energy-efficient motors; and lighting. Construction cost totaled $1.5 million for these facilities, encompassing 800,000 million square feet.

Contact: Tom Rosati

Telephone No.: 413-785-6254

Year Completed: 1993

Massachusetts Port Authority, Logan International Airport*, East Boston, Massachusetts*

XENERGY was responsible for the design specifications and construction services for a direct digital control energy management system for almost the entire airport complex. This new system consists of 2,900 points of energy management and fire system control, multiple stand-alone field interface devices, and two primary operator stations. The cost was $1.7 million.

***Massachusetts Water Resources Authority**, Boston, Massachusetts*

XENERGY designed and implemented a state-of-the-art remote water flow monitoring and telemetry communication system for 28 separate sites, including underground pumping and metering chambers for the water supply system that serve most of Boston and surrounding towns. The total project cost was $6.2 million. The 1,000-point monitoring system included detailed design specifications for specialized software and the successful integration of computer equipment from two vendors.

***Department of the Navy, Navy Public Works Center, Washington Navy Yard,** Washington, D.C.*

XENERGY conducted an energy study of the central district heating system serving Marine Corps Base Quantico in Quantico, Virginia. Steam service is currently supplied by the Mainside Central Heating Plant and 130,204 linear feet of above- and below-grade steam distribution and condensate return piping. The purpose of the study was to investigate the technical and economic feasibility of the six operational alternatives, or options, to the status quo operation of the central heating plant. Based on XENERGY's evaluation, the system will be converted to a distributed boiler system. Savings from elimination of distribution system piping resulted in an annual savings of $1,531,641, or 32.5 percent, over current baseline operations.

Contact: Mark Sanders, PE, CEM
Telephone No.: (202) 685-8450
Year Completed: 1999

***SDG&E O&M Program,** San Diego, CA.*

Through its contract with San Diego Gas and Electric, XENERGY conducted pre- and post-retrofit measurement and verification visits to provide the government with documented load impacts from energy efficiency measures installed under SDG&E's O&M Program at various Navy and Marine Bases in the Greater San Diego area.

SDG&E 1994, 1995, and 1996 Commercial EEI Program First Year Load Impact Evaluation, Military Sector, *San Diego, CA.*

Through its contract with San Diego Gas and Electric, XENERGY conducted measurement and verification activities to provide the government with documented load impacts from energy efficiency measures installed under SDG&E's Commercial EEI programs for 1994, 1995, and 1996 at various Navy and Marine Bases in the Greater San Diego area.

Energy Conservation Study, National Naval Medical Center, *Bethesda, MD.*

Provided all engineering services necessary for preparation of comprehensive energy and water audits on Medical Complex, Buildings 1-10.

Utility Cost Allocation Study, National Naval Medical Center , *Bethesda, MD.*

Developed utility consumption indices (electric natural gas, steam, chilled water, and water) of certain space types for cost allocation purposes on 220 buildings covering 2,300,000 square feet.

Energy Conservation Study Anacostia Naval Station, *Washington, D. C.*

Provided all engineering services necessary for preparation of comprehensive energy and water audits for all eligible buildings, including steam/chiller water plant and associated distribution lines.

ID/IQ for Energy Conservation Studies, *U. S. Navy WDC PWC Bureau of Medicine.*

At various east coast Navy Medical Clinics, provided all engineering services necessary to complete comprehensive energy and water studies.

Energy Conservation Study, U. S. Naval Observatory, *Washington, D. C.*

Provided all engineering services necessary for preparation of comprehensive energy and water audits for all eligible buildings, including steam/chiller water plant and associated distributions lines.

Audit and Project Identification Services, Various Navy and Marine Bases, Greater San Diego Area, *San Diego, CA.*

Conducted and prepared energy-efficient lighting audits for Naval facilities in the greater San Diego Area under contract to SDG&E. Audited over 16 million square feet of building space in four months.

Comprehensive Building energy Audits and Analysis, General Services Administration

At various locations in Pennsylvania and New Jersey XENERGY performed audits that identified and quantified cost-effective tuning, O&M, energy conservation measures, and water conservation measures using life cycle cost analysis.

Energy Star Building Program, EPA

Work in conjunction with EPA's office of Atmospheric Pollution Prevention Division to reduce emissions of greenhouse gases and other pollutants in commercial and industrial facilities through investments in cost-effective technologies that increase energy efficiency.

New York Power Authority, *New York, New York*

XENERGY has served as one of several implementation contractors for the Power Authority's lighting efficiency program. Over the course of four years, XENERGY has completed hundreds of audits of public buildings, ranging from schools to airports. After an audit's findings have been approved, XENERGY acts as implementation contractor, purchasing the lighting materials and hiring contractors for installation. The value of work completed to date totals more than $45 million.

D.1.6 Program Impact Evaluation

Impact Evaluation of the 1994-1995, 1996-1997 & 1998-1999 Industrial Programs - Portland General Electric

A sample design was developed to optimally allocate evaluation resources. Lighting, HVAC, and process end-use measures were evaluated using a site-specific approach. A self-report net-to-gross survey and analysis was carried out. Sites included industrial facilities in and around Portland and Salem Oregon.

Contact: Sharon Noell
Telephone No.: 503-464-7491
Year Completed: 2001

Public Service Company of Colorado Bid II DSM Program

XENERGY conducted pre-retrofit and post-retrofit peer reviews of proposed energy efficiency projects for Public Service Company of Colorado's Bid II DSM Program. XENERGY reviewed contractor submittals for energy efficiency work and approved their energy savings calculations. XENERGY then conducted on-site, pre-retrofit audits to confirm the baseline equipment and validate the contractors' savings claims. Following installation, XENERGY conducted post-retrofit verification audits to verify installation. Pre- and post-retrofit power monitoring was also conducted by XENERGY for selected sites.

Contact: Susan Pierson
Telephone No.: (303) 294-8893
Year Completed: 1998

Impact Evaluation of the 1997 Industrial Retrofit Program - PG&E

This impact study focused on industrial process and lighting measures. Process projects were evaluation using a site-specific engineering approach, often supported by metering. The lighting analysis was developed from on-site surveys, utilizing logger data when necessary, and included

HVAC interaction effects. All the site evaluation results were statistically combined using a ratio estimation approach. Net-to-gross estimates were determined using survey information from the decision makers for each site.

Contact: Mary O'Drain
Telephone No.: 415-973-2317
Year Completed: 1997

1994, 1995, 1996 & 1997 Industrial Energy Efficiency Incentives Program First-Year Impact Study - SDG&E

Site-specific analysis and net-to gross analysis were conducted for an average of 20 industrial process measures installed at 13 sites each program year. An engineering approach supported by metering was utilized to develop gross impacts, and a self report net-to-gross analysis was utilized to determine the net impacts.

Contact: Athena Besa
Telephone No.: 619-654-1257
Year Completed: 1998

Energy Efficiency Impact Evaluation - Hawaiian Electric Company

XENERGY is responsible for all DSM impact evaluation activities at Hawaiian Electric Company and its subsidiaries. XENERGY developed the evaluation plan in 1995 and has been responsible, on a on-going basis, for all monitoring, site surveying, engineering modeling, analysis, and report writing associated with determining the energy savings and peak demand impacts from all of HECO's DSM programs. The HECO programs involve lighting, HVAC, motors, and various control technologies in the commercial sector and water heating technologies in the residential sector. XENERGY utilizes a combination of monitoring and engineering analysis to determine the program impacts.

Contact: George Willoughby

Telephone No.: 808-543-4741

Year Completed: 2001

D.2 QUANTUM CONSULTING QUALIFICATIONS

Multi-Program Evaluation: Baltimore Gas & Electric. QC assisted BGE in undertaking a series of comprehensive impact, market and process evaluations of its residential, commercial, and industrial DSM programs. Impact evaluations were completed for the Residential HVAC and EnergyWi$e New Homes Programs and Nonresidential HVAC, lighting, new construction, and motors and compressors programs. Evaluation techniques included DOE-2 modeling, statistically-adjusted engineering (SAE) analyses, and billing/load data analysis, supported by extensive end use metering, on-site surveys, and phone surveys.

For BGE's major nonresidential programs, QC performed systematic, multi-faceted market and process evaluations. These evaluations have been performed for BGE's Commercial Lighting Program, Commercial New Construction Program, Commercial HVAC Program and Industrial Plant Expansion and Major Equipment Program. The evaluations have focused on measuring customer satisfaction, efficiency and effectiveness of program delivery, market penetration/potential, and adequacy of the program's tracking system. Market penetration and customer satisfaction models were developed as a function of program delivery scenarios. QC's broad experience with market and process evaluations has produced valued results for BGE that have contributed to improved program performance.

Integrated Evaluation: Model Energy Communities Program (Delta Project). QC conducted an integrated evaluation of PG&E's Delta Project. The Project is an innovative, geographically targeted DSM program designed to reduce PG&E's transmission and distribution (T&D) requirements. In Phase I of the project, QC developed a comprehensive evaluation plan for conducting impact and process evaluations. The impact evaluation included both whole-premise and end-use load metering, as well as kVAR metering of residential participants. QC designed and administered multiple surveys to assess participant awareness of and satisfaction with the program. QC performed detailed cost-effectiveness calculations using the evaluation results. Phase II evaluation activities included developing and implementing a commercial participant survey to assess these customers' reactions to the program, as well as performing billing data analysis for both commercial and residential participants. In addition, QC provided support for commercial customer metering activities and performed an analysis of PG&E's Early AC Replacement Program, which is part of the Delta Project. QC performed a cost-effectiveness study for both the residential and commercial program components.

SCE Large Customer Needs and Wants Study. The goal of this project was to assess the needs of California's largest commercial and industrial sector customers and to determine the synergies between these needs and the efficiency- and load management-related goals of the California investor-owned utilities. Market intelligence on five important California industry segments – biotechnology, semiconductors, aerospace, fruit and vegetable processing and hospitals – was gathered through workshops with key industry experts and in-depth background research. The program strategies recommended to meet the needs of these large customers range from enhanced programs to directly increase energy efficiency and reliability through joint efforts to enhance productivity and efficiency, build cooperative relationships between utilities and their large customers, and provide assistance to these customers in this era of competitive transition in the utility industry.

Market Effects Study of PG&E's Energy Efficiency Training Center. A representative group of customers were interviewed that had attended the 1998 energy efficiency training sessions provided by PG&E's Stockton Training Center. The survey respondents were a mix of trade members (contractors, designers, and consultants), and end users (typically facilities/operations staff), across the full range of training session topics. The express purpose of the survey was to assess whether PG&E's Stockton Training Center had met the following energy efficiency milestone: (1) at least 50% of the attendee population has applied (or plans to apply) knowledge "to achieve energy efficiency results," and (2) at least 50% of the attendee population has (or plans to) spread their training-based knowledge, among "others who did not participate in these courses." This milestone was met.

Evaluation of PG&E's Commercial Energy Efficiency Incentives program. QC has conducted impact and process evaluations of this major C/I sector program for the past four years, with the final evaluation completed in early 2000. The program, which was one of the largest rebate incentive programs in the country, provided rebates to commercial customers for installing high efficiency lighting, HVAC, motors and agricultural equipment. The project involved work involved the estimation of impacts for each type of equipment covered by the program, requiring and creating immense familiarity with an array of C/I sector technologies from both an engineering and market penetration perspective. QC also accumulated considerable experience collecting data on equipment efficiency in these projects. As part of these evaluations, QC conducted telephone interviews of approximately 4,000 commercial customers per year. These interviews collected information on current HVAC equipment penetration and new installations. On-site audits were conducted to verify and enhance existing information. Finally, mail surveys were occasionally used to collect additional detail regarding installed HVAC equipment.

Residential, Commercial, and Industrial DSM Program Evaluations, Florida Power & Light. QC is conducting the largest, longest-running and most comprehensive integrated evaluation of energy efficiency and load control programs in the country. This ongoing engagement for Florida Power and Light many of the highest potential impact energy efficiency options being offered across the country, including:

- Residential central HVAC, room air conditioners, duct repair, ceiling insulation, window treatment, water heating and on-site energy audits
- Commercial/industrial sector lighting, unitary HVAC systems, chillers, thermal energy storage, and building envelope (both insulation and window treatment)
- Residential and C/I sector load control programs.

The overall goal of this long-term engagement is to assist FPL in its efforts to continue enhancing program performance, thereby maximizing the value of its energy efficiency products and services to all FPL stakeholders. Through our integrated evaluation approach, we have assisted FPL in developing and meeting long-term energy efficiency and load control goals, while identifying program improvements that reduce program costs by as much as 60 percent, a cost savings worth many times the evaluation expenditures.

In the process evaluations, the effectiveness of program implementation is assessed by examining both the effects of the program on customer satisfaction and the effectiveness of the program delivery mechanism. These satisfaction analyses, when combined with assessments of the effectiveness of program delivery processes, provide FPL with the information needed to maximize program effectiveness.

All of the data used in these multi-year evaluations is combined in a relational marketing database that is the integrated data source for all evaluation activities, and is used by FPL in its program planning and implementation activities.

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RESUMES

JOHN C. SKELTON

SUMMARY

John Skelton has more than 20 years of experience developing and delivering technical services to help industrial customers reduce operating costs and improve productivity. These services have included: compressed air system efficiency, manufacturing process assessments, fuel supply management, energy project development, and facility outsourcing.

His experience spans the full range of functions associated with an energy services business: sales lead generation and screening; plant assessments; project specification, contracting, and implementation; and savings verification. He is currently working on several major initiatives to identify and implement compressed air projects on a state-wide basis. Over 30 sites have been evaluated with an average energy cost reduction of more than 30% via projects reflecting an 18-month payback or less. More than 70% of the recommended projects will be implemented by customers.

EDUCATION

Cornell University: Master of Engineering
Cornell University: Master of Business Administration
Cornell University: B.S. in Industrial Engineering/Operations Research

EXPERIENCE HIGHLIGHTS

XENERGY Inc., Columbus, Ohio, 1995-Present.
Director, Industrial Services. Responsible for compressed air system projects and other industrial energy services, customer program implementation, and non-regulated utility business venture development.

Resource Dynamics Corporation, Columbus, Ohio, 1990-1995.
Director, Utility Services. Responsible for energy market assessment and technology evaluation.

Battelle - Columbus Division, Columbus, Ohio, 1978-1990.
Manager, Industrial Programs. Responsible for technical service program development, industrial DSM, industrial energy market assessments, and energy program implementation.

FIELDS OF SPECIAL COMPETENCE

- Compressed Air Programs
- Industrial Technical Services
- Productivity and Environmental Strategies
- Energy Program Design and Implementation
- Vendor and Utility Alliances
- C&I Technology Assessments
- End-Use Energy Analysis
- Market Segmentation

MAJOR PROJECTS AND PRODUCTS

Compressed Air Systems

- Designed and implemented compressed air program targeted on manufacturers in three states – ongoing program has reached over 30 customers and identified savings averaging 30% based on projects with less than a 18-months payback – over 70% of the projects are expected to be implemented using local vendors

- Designed and implemented major contract for Department of Defense to upgrade compressed air systems at six military-operated manufacturing sites. Project includes the design and installation of gas engine systems to enhance existing systems at two sites.

- Designed and implemented state-wide program to identify and implement compressed air programs in New York – program involves working with 12 local vendors and 24 customers to save over 4,000 MWh as a first step in a market transformation program.

- Designed and implemented program to identify and implement compressed air programs in Ohio – program worked with industrial customers through the local power company.

Energy and Technical Services Programs

- Designed and implemented comprehensive energy and technical service program offering chiller retrofits, lighting retrofits, motor assessments, process heating improvements, power quality assessments, environmental studies, and capacity expansions

- Designed and implemented statewide industrial productivity improvement program linking business firms of all sizes with engineering resources in the state.

- Managed energy audit program for major utility--program focused on lighting and motor retrofits to accelerate implementation of conservation measures.

Technology and Market Assessments

- Developed screening tools ("20 QUESTIONS") to help staff qualify customer leads--separate screening tools were developed for compressed air systems, adjustable speed drives, heat pumps and heat recovery systems, wastewater treatment, and process heating technologies.

- Conducted economic and market assessment of 15 conservation technologies -- evaluations were then extrapolated to develop state and national estimates of energy impacts.

- Established clearinghouse and centralized database of industry-wide estimates of technology performance, energy impacts, and market potential and penetration rates.

HENRY P. VAN ORMER, JR.

EDUCATION

BA Business Administration, Gettysburg College, 1959
Graduate Studies, American University
Graduate Studies, Kent State University
Graduate Studies, Akron University

EXPERIENCE HIGHLIGHTS

Xenergy, Inc., Worthington, Ohio, 1999 - Present
Technical Director. Responsible for technical quality on all compressed air system reviews. Served as lead auditor on projects for PG&E, Central Vermont, NYSERDA, and CERL. Lead author on NYSERDA guidebook on conducting plant assessments and collecting data.

AirPower USA, Inc., Pickerington, Ohio, 1986 - Present
President. Responsibilities include conducting compressed air system audits at various plant facilities throughout the country. During walkthrough audit, compile and analyze data on compressed air systems, troubleshoot problem areas, and recommend improvements and upgrades to current compressed air systems. Upon completion of audits, prepare compressed air reports for plant manager including equipment specifications and cost data.

Compair Kellogg, Inc., Kingston, New Hampshire, 1983-1986
Marketing Manager. Supervised 35 people including field sales force/product service group/application engineers & product managers/customer service & order entry/marketing/advertising, and print shop. Helped in turnaround situation as company was changing from a petroleum equipment supplier (gas station) to a significant industrial compressed air supplier in the U.S. for all Compair Products. Developed business plans, action plans, and significant interface among five other plants in Canada, United Kingdom, and Mexico that supplied over 50 percent of the business.

Oversaw complete restructuring during which sales climbed from $15 million to $22 million by improving margins through selective account sales and product mix and bring the company from a significant loss to a break even or small profit level.

Ingersoll-Rand Air Center, Tulsa, Oklahoma, 1982-1983
Manager. Supervised the start up of a full service air center in Tulsa to back up all Ingersoll-Rand industrial and construction sales and work closely the I-R gas compression group. Facility was fully operational within four months of start up, including locating a facility site, and hiring and training all personnel for sales, parts, service, and custom fabrication. Operation exceeded all sales goal and was profitable within the first year.

Finnell Compressor Company, Tulsa, Oklahoma, 1978-1982
Marketing/Sales Manager. Responsible for developing marketing and business plans and supervision of sales and product engineering groups; product lines included air compressors (engine and electrical motor driven), air tools (industrial and construction), hoist and winches, air starters, boosters, and special packaged air systems for the oil and gas market.

Ingersoll-Rand Corporation, Davidson, North Carolina, 1973-1978
Marketing Manager, Air Power Division. Responsibilities covered Air Power Division products, including electric motor-driven rotary screws, single and double acting reciprocating units, booster compressors, etc. and included overseeing marketing, order entry, forecasting, field autonomous company pricing, writing market plans, competitive analysis, and new products.

Worthington Compressor & Engine International, Holyoke, Massachusetts, 1968-1973
Product Manager. Reported to Marketing Manager, Construction Equipment. Prepared quotes, pricing, market plans, sales literature, advertising, forecasts, and job cost estimates. Coordinated all drill demonstrations and conducted drill and blast seminars for rock contractors.

MAJOR PROJECTS

- Compressed Air System Assessments:
- Eveready Battery
- Vermont Castings
- Vermont Tubbs
- Harbour Industries
- Vestshell
- Start up of full-service industrial air center
- Oil analysis program for screw compressors
- Special ski and snowmaking unit
- High pressure units for underground mining market
- Development and promotion of “Wrangler” rock drill

FIELDS OF SPECIAL COMPETENCE

Compressed Air System Analysis

Equipment Specification and Cost Estimating

Sales and Marketing

Troubleshooting in Corporate Environment

REPORTS, PUBLICATIONS, AND PRESENTATIONS

Author of numerous technical articles on rock drills, rock drilling, blasting, engine compressors, electric motor compressors and rotary screw compressors in numerous industrial publications.

PROFESSIONAL AFFILIATIONS

International Society of Explosive Engineers
Association of Mechanical Engineers

Southern Gas Association

WILLIAM SCALES, P.E.
Scales Air Compressor Corporation

William Scales is an internationally recognized expert in compressed air systems. Over the last 40 years, he has visited more than 5,000 facilities and audited hundreds of compressed air systems throughout Asia, Australia, South America, and the United States, including Boeing, Ford, General Motors, IBM, John Deere, Mobil, Sunoco, and other Fortune 500 corporations. He has hands-on knowledge in operating and maintaining compressors, which was developed from years of experience in servicing and overhauling air compressors during the early stages of his career.

Publications

Compressor Engineering Data
Air Compressors and the Compressed Air System
Air Compressor Energy Audit
Compressor Lubrication – STLE Handbook
Assessing Processes for Compressed Air Efficiency

Affiliation

Chief Executive Officer
Scales Air Compressor Corporation – A company with five locations in New York, New Jersey, Connecticut, and Pennsylvania that employs 170 people to rebuild, service, engineer and sell air compressor systems.

President
Air Compressor System Consultants, Inc. – A company providing consulting engineering services for all types of compressed air systems to major industrial users throughout the world.

Education

Bachelor – Electrical Power and Mechanical Engineering, New York Polytechnic University

Professional Association

Member of the Department of Energy Compressed Air Challenge Project Development Committee and Technical Core Group.

An original and current member of the Project Development Committee that is responsible for program strategy and overall project coordination. Represents compressed air consultants and their concerns to the Compressed Air Challenge™. Reviews and edits articles which will be written with Compressed Air Challenge sidebar notation. A member of the Technical Core Group that defines and writes the training curriculum. As a pilot instructor, presented the introductory program to the board of sponsors and new instructor trainees. Selected as a qualified instructor for advanced training for managing compressed air systems.

National Society of Professional Engineers

Member of American National Standards Institute ZII Compressor Panel and International Standards Organization TC28 Committee engaged in developing standardized specifications and appropriate lubricants for all types of air compressors.

HENRY L. KEMP, JR.

PROJECT EXPERIENCE

Xenergy, Inc. (2000 - Present) – Senior auditor on compressed air assessments. responsible for audits and leak surveys for NYSERDA, CERL, and PG&E programs. Conducted workshops for compressed air training for NYSERDA.

Compressed Air Challenge (1997 - Present) – Member, Training Core Group. Pilot instructor for U.S. Department of Energy's collaborative for energy conservation in industrial compressed air systems. Qualified as Level I and Level II instructor.

Strategic Air Concepts (1995 - Present) – Owner/President. Specialists in survey, audit, and design of industrial compressed air systems. Emphasis on energy conservation and substantial cost operating dollar and energy savings on large industrial compressed air systems.

Ingersoll Rand (1957-1993)– Area Manager for State of Florida, Air Compressor Group. Responsible for all sales, service, rentals, distributor training, and all financial aspects for compressed air systems and accessories up to 5,000 horsepower.

- Southeast Distributor Sales and Service Development. Worked to reconfigure distributor operations in North Carolina, South Carolina, and Tennessee
- Northeast Regional Manager for Distributor Sales
- National Account Manager for T-30 Products
- Product Manager, Michigan, Responsible for sales of centrifugal pumps, pneumatic tools, and compressed air systems.

FIELDS OF SPECIAL COMPETENCE

Energy Audits	Energy Analyses and Conservation
Equipment Surveys and Inventories	Conservation Project Evaluation

KEY CLIENTS

Gladding-McBean Company	AT&T Automotive
Lockheed Martin	Georgia Power Company
Tampa Tribune	Ralston Purina Company
Commonwealth Edison	FSC Paper Company
Union Electric Company	Lone Star Industries
Didion & Sons Foundry	Cheeseborough-Ponds, USA
Chrysler Corporation Assembly Plants	Van Hoffman Press
Sun Main Raisin Company	Pacific Gas & Electric

EDUCATION

University of Detroit, Mechanical Engineering Studies

DAVID BEARY

EDUCATION

Pennsylvania State University: Bachelor of Science – Civil Engineering

EXPERIENCE HIGHLIGHTS

XENERGY, Inc., 2000 - Present.
Manager, Technical Services. Conducts plant audits of compressed air systems; evaluates cost savings projects and manages project installation and vendor coordination.

Air Power of Ohio., 1983-1998.
President/Vice-President/Sales. Profit and loss responsibility for $14M sales, service and rental company. Over a 2-year period, we increased sales from $10.4M to $14M culminating in a buyout. Responsible for 55 people and all business functions.

Ingersoll Rand Co., 1971-1983.
Regional Manager
North Central Region. $10M revenue, 9 states, 10 sales engineers, 15 servicemen and a support staff of 4 engineers and 3 clerical people.
Southeastern Region. Georgia, Kentucky, Tennessee, Virginia, Alabama, North Carolina, South Caroline, and Florida; consistently finished in the top 20% of regions nationally.

Air Center Manager. Started sales and service operation from scratch, hired people and found location and trained all 12 people in the operation. We were breakeven the first year and profitable the second year of operation.

Service Manager – Pac Air Division. Responsible on a worldwide basis for parts distribution, warranty claims, training of service personnel, Air End exchange program, legal entanglements for product failures, field service. The division was new and I set up the various departments. During that time, we had reliability problems with ball bearings and I was involved with engineering in the design of a replacement line of machines.

Marketing Manager – Pac Air Division. New product introduction requiring coordination between engineering and manufacturing to phase out an old line of product while brining up a new line. First year sales were $3.5M, second year $10M, and $14M third year.

General Territory Salesman. Responsible for Upstate New York and Arkansas. Called on major accounts for Ingersoll Rand selling pumps and compressors, condensers, ejectors, rock drills, and construction equipment.

DONALD S. VAN ORMER

EDUCATION

New Hampshire Vocational Technical College: Associate Degree – Applied Electronics
Oklahoma State University: General Course of Study

EXPERIENCE HIGHLIGHTS

XENERGY, Inc., Columbus, Ohio, 1999 - Present.
Technical Support. Help compile and analyze data on compressed air systems at various corporate plant facilities; assist in troubleshooting problem areas and recommending improvements and upgrades to current compressed air systems; prepare reports for plant manager including equipment specifications and cost data.

American Business Systems, Tulsa, Oklahoma, 1989-1999.
Sales and Service Technician. Serviced various office machines including copiers, fax machines, and laser printers; troubleshooting service problems; sales of new machines, and parts and supplies for current office machines.

Business Products of New Hampshire, Concord, NH, 1987-1989.
Field Service Technician. Serviced office equipment on-site at customer's place of business; service troubleshooting and sales of machines, service contracts, parts and supplies; responsible for customer training in eastern New Hampshire.

Air Power USA, Inc., Strafford, New Hampshire, 1986-1987.
Technical Support. Prepared market studies and competitive analyses; responsible for technical literature development.

FIELDS OF SPECIAL COMPETENCE

- Compressed Air System Analysis
- Direct Customer Service
- Sales and Follow-up Service
- Equipment Specification and Cost Estimating
- Troubleshooting Office Machinery

MAJOR PROJECTS AND PRODUCTS

Compressed Air System Assessments:

- Eveready Battery
- Vermont Castings
- Harbour Industries
- Vestshell
- Ohio Aluminum
- TFO Tech
- ISP Fine Chemicals
- Vermont Tubbs
- Ball Foster Glass
- Wyeth Nutritionals
- Capstan Atlantic
- Ross Products
- PlastiPak
- Hayes Lemmerz
- Foxboro Company
- PPG
- Avery Dennison

KRIS BRADLEY, Principal
Quantum Consulting

EDUCATION

Humboldt State University, Bachelor of Science – Environmental Resources Engineering

EXPERIENCE HIGHLIGHTS

Mr. Bradley has many years of project management experience and consulting expertise in the energy industry, focusing on mechanical engineering analysis for energy efficiency program evaluation. Mr. Bradley earned his E.I.T. certificate with the State of California.

In addition to his engineering and management experience, Mr. Bradley has worked on residential, commercial and industrial DSM projects for both Pacific Gas & Electric and Florida Power & Light. His engineering experience includes analyses surrounding lighting, HVAC, refrigeration, motors, building envelope, hot water and air compressor technologies; Mr. Bradley has extensive energy conservation and program design knowledge in both the residential and nonresidential sectors.

He brings a comprehensive knowledge of equipment retrofits and the mechanical and thermodynamic properties of those technologies, familiarity with a broad spectrum of utility program databases, and a strong background in program design. Mr. Bradley has worked extensively with end-use metering, on-site audit and telephone interview sample design, and the integration of these resources to successfully complete client projects on time and within budget.

Mr. Bradley is an expert at algorithm development, detailed site-specific mechanical systems analysis, and the implementation of DOE-2 and other building simulation models. Prior to joining QC, he was a research engineer with DeLima Associates, a consulting firm providing analytical support for the Gas Research Institute and the Department of Energy. Mr. Bradley's experience includes the analysis of the prototype York gas heat pump performance and cost-effectiveness evaluation carried out for both the Gas Research Institute and the Department of Energy. Previous work also includes analysis of building energy consumption under the California Building Energy Standards.

Mr. Bradley has participated in several notable evaluations of compressed air technologies. His experience in this area includes a thorough evaluation of the impacts attributable to compressed air system improvements and retrofits, the program process surrounding those retrofits and the factors that lead decision-makers to make these process improvements, as well as barriers to those efforts. A brief description of applicable efforts that emphasize program impacts is provided below:

- Integrated evaluation of Baltimore Gas and Electric's Plant Expansion and Major Equipment Replacement Program, emphasizing air compressor and motor retrofits. The compressor component involved compressor replacement in 11 facilities. Impacts were estimated using pre- and post-retrofit end-use metering data, highlighting the improved performance of double-acting reciprocating compressors with inlet valve unloading. The study emphasized the relatively poor performance of baseline compressed air systems operating under part-load conditions, for example, single-stage rotary screw compressors with modulation.

- Air compressor retrofit impacts were evaluated for the Consumers Power Company's Reduce the Use program. Compressed air retrofits were evaluated using spreadsheet-based models, developed using the program tracking system records and paper files in conjunction with individual technical interviews completed with each participant. Model results were then calibrated using end-use metering data from participant sites.

- Medium commercial compressed air retrofits completed under the PG&E Delta project were evaluated, emphasizing compressed air retrofit impacts. Impact models were developed using program tracking system records and paper files in conjunction with individual technical interviews with each participant.

SIGNATURE PAGE

I, Rich S. Barnes, certify that I have read this document and know its contents; that to the best of my knowledge, information, and belief, formed after reasonable inquiry, the facts are true as stated; that any legal contentions are warranted by existing law or a good-faith argument for the extension, modification, or reversal of existing law; that the document is not tendered for any improper purpose; and that I have full power and authority to sign this document.

Rich S. Barnes
Senior Vice President of Implementation
Systems and Services
XENERGY, Inc.
492 Ninth Street, Suite 220
Oakland, California 94607
rbarnes@xenergy.com
(510) 891-0446

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